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ORIGINAL ARTICLES.

I.—On the very Recent and Rapid Elevation of the Highlands of Eastern Asia.

By Henry H. Howorth, Esq., M.P., etc., etc.

AMONG the many interesting issues raised by the discovery of Mammoth remains in large numbers along the Arctic borders of Eastern Asia, one has, I think, ceased to be polemical. So far as I know, there is no serious student who now contests the fact that the Mammoth and his companions lived where their remains are found. The rooted trees upon which they fed, and the southern river-shells which were their contemporaries, both of which are found with their remains (both being incapable of migration), prove incontestably what a score of other arguments show, that the fauna of North-Eastern Siberia in the Mammoth age, like its flora, must be explained by some other theory than migration. This I have urged in many ways in my work on the Mammoth.

If the arguments I have recently adduced in the Geological Magazine to show that the two great rivers of Western Siberia flowed southwards and not northwards in the Mammoth age be sound, they give the finishing blow to what has virtually ceased for many other reasons to be a tenable theory, namely, that the Mammoth carcases and the vast débris of the animal world found on the mainland and on the islands off the coast of Siberia are the results of river portage. Against this last theory I have also tried to converge a large number of arguments, old and new, in the work just cited.

There remains only one possible conclusion, as I said at starting, namely, that the great beasts whose remains abound so much in the tundras east and west of the Lower Lena on the Bear Islands, etc., lived where their remains occur, as the Russian explorers and as our most experienced writers agree.

This conclusion necessitates our postulating that the area in question in the time when the Mammoth lived, instead of being as now a bare tundra covered with snow for the greater part of the year, and swept by icy winds, with a short summer of little more than six weeks, was sufficiently temperate in climate to permit an abundant and accessible vegetation to exist all the year round, not only up to the present border of the Arctic Sea, but right across from Siberia

to Alaska. This deductive axiom is inductively proved by our finding the remains of this same vegetation rooted in the very beds where the Mammoths lie, and far beyond the present limit of forest growth. The fact has to be explained in some way by those students who do not emulate the conduct of the ostrich by hiding their heads in the sand to baffle every pressing difficulty, and who recognize that all hypotheses, however supported by authority, are in essence tentative.

How, then, are we to explain a change of climate so important and so considerable? What are the conditions which impose such a hard climate upon North-Eastern Asia, and under what hypothetical conditions could we reasonably postulate a fairly temperate climate in the Bear Islands, the Chukchi peninsula and Alaska? It seems to me that the severe climate of North-Eastern Asia is governed partially by the fact that that area is in close contact with and bounded on the north by the Arctic Sea, which is a reservoir of cold, and partially and probably to a greater extent by the fact that it is in close contact with and bounded on the south by the icy plateaux of Mongolia and Tibet. It seems to me, further, that if we could remove these two sources of cold, we should at once transform the climate of the district we are discussing from one of extreme Arctic severity to one of a moderate and perhaps even temperate character.

I will first say a few words about the Polar Sea. It is an opinion very generally held that a continental climate presents much greater contrasts, and is in effect more severe than a maritime or insular climate, which has its extremes tempered by the continued presence of water, and the isothermal lines of the world are a singular proof of the general truth of the position. The position is nevertheless only partially true. It is only true when the water is in the shape of water. When the water is frozen and remains frozen all the year round, and is consequently *never* above the freezing-point, but always below it, the proximity of a great mass of water, instead of acting as a tempering instrument, acts as a perpetual refrigerator, and every wind that blows across it and over the land is an icy cold wind. Hence the Polar Sea, so long as it remains frozen, has the effect of greatly intensifying the natural climate due to a high latitude; and if it were removed, and replaced by a mass of land, the effect would be much the same as if its waters were unfrozen: the result would be in fact to greatly temper the climate.

I have tried to show in a previous paper that when the Mammoth lived, the polar area, or a considerable portion of it, was necessarily dry land, otherwise that animal and its companions could not have passed to and fro between Siberia and America, as we know they did, and as we also know they did in very high latitudes. Hence, it follows that when the Mammoth lived, either there was no Polar Sea, or its area was greatly contracted, and thus this reservoir of cold did not exist to continually sophisticate the north wind with its icy touch. *Pro tanto* the effect of this must have inevitably been to modify the climate in the direction of making it more temperate and genial.

This I have urged before in these pages. We must not, however, exaggerate this cause, and attribute it to more than it can explain.

When we inquire why the climate of the valley of the Lower Lena, and notably Yakutsk, should be so exceptionally severe, as compared with almost every other place on the same parallel of latitude, we shall find that it is due not so much to the prevalence of excessively cold north winds, but to the prevalence of excessively cold south winds: especially is this the case in summer, when in many other areas on the same parallel the south wind brings a balmy memory of the tropics with it. Here it always comes from the sterile cold plateau of Tibet. It then flows across the Mongolian highlands, and, after blowing over such a wide space of very elevated land, it is not only drained of its moisture, but is also cooled down to a low temperature. Hence at Yakutsk the south wind is often nearly, if not quite, as terrible a visitor as the north wind.

If therefore we are to trace the present severity of the climate of North-Eastern Asia to its most potent and efficient cause, we must trace it to the existence of vast masses of mountain land and high plateaux culminating in the Thian Shan, the Kuen Lun, and the Himalayas and including the Altai range and the great upland steppes of the Pamir of Tibet and of Mongolia proper.

So long as this vast refrigerator exists in Asia, so long does it seem to me must the climate of North-Eastern Siberia remain a very cold and severe climate, and one incompatible with vast herds of herbivorous animals finding suitable food in the latitude of the Bear Islands; and if we are to find the efficient and real cause of a once temperate climate, where everything is now so palpably the reverse, we must inevitably postulate the non-existence in the Mammoth age of these great masses of high land. I have no hesitation in doing so. The suggestion was made long ago as a suggestion merely, by a much greater man than myself, whose sobriety of argument and ripe judgment have been somewhat overshadowed lately by more imaginative forms of scientific reasoning. I mean Alexander von Humboldt. Humboldt argued that the rise of the Ural and Altai Mountains, and with them of enormous masses of the continent of Asia, must have so refrigerated Siberia, that its forests, which in the halcyon days of Mammoths may have extended in certain promontories to near the Icy Sea, had necessarily shrunk back to their present limits, and left these coasts entirely to the Reindeer and its mosses (Russia and the Ural Mountains, vol. ii. p. 497). Let us now see how this view can be supported inductively.

The first remarkable fact to which I would call attention is one that arrested notice long ago, namely, that in the Altai Mountains, which are very lofty and otherwise well adapted to nurse large glaciers, no traces of the so-called Glacial Age can be found. No striated rocks, no ancient boulders. This is assuredly a remarkable fact. It is attested by more than one reputable witness. One of the first trained geologists who visited the Altai Mountains was Pierre de Tchihatcheff, who published a very fine work on that chain in 1845. He remarked in it on the absence from the Altai as from the Ural

chain of any erratic blocks so far as his observations went (*op. cit.* pp. 396–7). In 1871 another special work on the geology of the Altai was published at Leipzig by the famous geologist Bernhard von Cotta. *Inter alia*, he remarks on the complete absence in the Altai of any traces of a Glacial age, or of such evidences of an Ice age as exist in Western Europe. He says that General von Helmersen had failed to find any traces of erratic blocks of rounded rocks or of polished surfaces; while he himself, in spite of an eager search, had "not been able to find the slightest evidence of anything of the kind either in the subordinate ranges and hills or the deeper valleys, although the mountains there are from seven to eleven thousand feet high, and at present a few small glaciers are to be found in the south-eastern part of the range; and," he adds, "those who would explain the absence of old glacial action in the Urals from the fact of their comparatively low altitude cannot use the same argument here." In another place Von Cotta remarks again on the fact that the Altai range offers no traces of a former Glacial period or of an Ice age (vide *op. cit.* pp. 65 and 107).

The two ranges of the Urals and the Altai therefore share in this common absence of traces of a so-called Glacial age, an absence which is also marked, as Humboldt long ago pointed out, in the plains which separate the two ranges. All this is assuredly very remarkable. That a vast congeries of mountains should have existed in the temperate zone of the northern hemisphere at the time when the Alps and the Dovrefelds were shedding their great trains of erratics far and wide and were covered with vast glaciers, and yet that there should be no traces of old glacier action among them, is explainable to myself by no other hypothesis than their non-existence at the time. As in the case of the Urals, to which I devoted the previous paper, the absence of traces of ice action is the best evidence that the Altai range did not exist when ice action was so developed on nearly every secondary mountain chain in the north temperate zone.

Again, it is a remarkable fact that among the animal remains found in the Altai caverns the Hyæna should occur. The Hyæna is, I believe, very rarely if ever found in the caverns on the flanks of the Alps or in those of the higher grounds of Germany, and was a frequenter of the warmer plains. That it should occur in the caverns of the Altai points again to that area having had a different contour to the present one. Altogether, it seems to me that in regard to the Altai range, such evidence as we have is completely consistent with the *à priori* view that these mountains did not exist during the Mammoth age.

If we turn from the Altai range to the mighty plateau which forms the great mass of Central Asia, and is buttressed on the south by the Himalayas, on the north by the Thian Shan range, on the west by the Pamir and the Hindu Kush, and on the east by the mountains of Corea, we have to deal with an area which has only been visited and traversed at a few points. The testimony of travellers, however, seems to be unanimous, whether they approach

this great upland from India, or Russia, or China, namely, in vouching for the absence of those most easily distinguished and most palpable proofs of wide glaciation which we meet with in Western Europe and in Eastern America.

The Russian traveller Severtzoff has described the existing glaciers of the Thian Shan, some of them still of enormous size, some shrinking and recently shrunk, in consequence doubtless of the gradual desiccation of the surrounding lowlands and consequent diminution of moisture.

When he turns to a former development of glaciers, which ought assuredly to have left enormous traces in this the very focus of modern glacier action, at a time when Central Asia, instead of being a dried-up waste, was occupied by a vast sheet of water, and when the conditions for the growth of glaciers were so favourable, what does Severtzoff say? I will copy his account, as communicated by Krapotkin to Reclu's great geographical work.

"Evidently the Thian Shan," he says, "has preserved its primitive aspect better than the Alps. It has been less carved out by rain, snow, and glaciers. While the névés and rivers of ice in the Alps once covered the plains and lowlands surrounding that range to a height of 200 metres, the glaciers of the Celestial mountains do not appear to have descended into the lower valleys, and a vigorous vegetation occupied the flanks of the mountains to a height of 750 metres above the level of the waters which bathed their feet. There has, in consequence, resulted a very different law of vegetable distribution. While the Alpine region has been itself colonized by species of plants growing in the forest outside it during the intensity of the ice, the zone of the Lower Thian Shan was the mother country whence species spread in one direction towards the higher summits, and in the other towards the dried-up plains."—(Severtzoff quoted by Reclus, Nouvelle Geographie Universelle, vol. vi. pp. 359–360.)

It would not be easy to adduce stronger evidence than this that on the great ramparts of mountains which form the northern frontier of the great Asiatic plateau there is not only an absence of traces of former great glacial development, but positive proof that no such conditions could have then existed.

If we turn to the other extremity of this great plateau girdled with mountains, namely, to Corea, we find the same story. Dr. Gottsche, in his memoir entitled Geologische Skizze von Korea, published in the 36th volume of the Proceedings of the Berlin Academy, says emphatically, "Glacial phenomena do not exist in Corea," and he quotes Richthofen's China, vol. ii. p. 111, as witnessing to the absence of similar phenomena from Liautung. Both Corea and Liautung are mountainous countries, and the former very much so.

If we now turn to the great southern buttresses of the Asiatic plateau, namely, the Himalayas, we shall find a repetition of what Severtzoff reports in regard to the Thian Shan range, namely, a large number of glaciers showing signs of shrinkage, of which Mr. Lydekker has given a very interesting conspectus. No doubt there

are traces of their having been bigger and stretched further, but these traces are nevertheless strangely limited in extent, considering the huge reservoirs of ice which the Himalayas must have been, in the so-called Glacial age, if the same conditions had prevailed there as prevailed in corresponding times in the Alps. We must not forget that not only was the southern monsoon there with its heavy rains, but the Asiatic Mediterranean was also then existing, so that we must not measure the amount of moisture then prevailing with what prevails now; and what is the testimony of the best observers on the subject? There has no doubt been a polemic in which many writers, such as Theobald, Wynne, Lydekker, Drew, and others have joined; but this has been rather about the extent to which the modern glaciers have shrunk: all admit recent glaciation in the higher valleys, but I know of no Indian geologist, except Mr. Theobald, who has contended for signs of vast glaciation, such as we find in the much smaller European ranges of the Alps and Dovrefelds. I would add that Strachey has published in the Encyclopædia Britannica a very useful diagram showing the comparative size of the Alps and the great Asiatic uplands, which is a very useful measure of the kind of traces of a glacial age we ought to meet in Eastern Asia. To revert, however: there is a general concurrence among observers that the phenomena in the Himalayas are on quite a small scale *comparatively*.

Thus, Mr. J. F. Campbell writes: "The Himalayan region is a slope about 200 miles wide between the upper plateau of Asia and the plains of India . . . . I looked at every stone and heap of stones about the foot hills, expecting to find some glacial mark. I looked at every hill top, expecting to find some remnant of a glacial record between the river gorges. . . . I stayed at Simla for some time, and found no sign of glacial action of any kind up to about 9000 feet. All the ridges which divide streams are sharp and steep as the ridge of a house. All the furrows are deep V-shaped, angular, steep gutters, like the gutter between two steep roofs. I could not discover one rounded hill or hollow, one 'saddle' or 'hogback,' from Simla, or from places near it to which I could travel . . . . The highest ground visible is a jagged sierra of pyramidal angular points, among which are the glaciers" (Quart. Journ. G. S. vol. xxxv. pp. 109–110). "Hirdswar is a sacred place where the Ganges leaves the hills. At the sources of the Ganges are glaciers. If these glaciers ever extended far during a Glacial period, some mark ought to be found about the place where a river as big as the chief river of Lombardy at its greatest size escapes from the great basin, whose jagged edges and steep sides I had seen from Landour, where frosts and deep snows occur frequently. In a like position in Italy, near Turin, are ramparts of glacial débris. Hirdswar is 1124 feet above the sea. The edge of the basin is nearly 20,000 feet higher, and the area is large and comparable to the area of the Val d'Aosta or the Lago Maggiore. . . . . I stayed at Hirdswar for several days, and could find no sign of glacial action whatsoever" (*id.* pp. 113–114).

At Roorkee, in digging a huge canal, there was found only mud,

sand, pebbles, and abundance of large, smooth, egg-shaped, rolled stones of considerable size. "I could not find," says Mr. Campbell, "one stone with scratches on it or with flat sides, or one angular erratic near the canal. I could find nothing glacial about the end of the Ganges basin. I could hear of nothing glacial from the surveyors with whom I conversed at Dehra. I had photographs of glaciers, and of glens near them, about the headwaters of the Ganges and the Sutlej. In them I could see nothing to suggest the former action of large glaciers like those which have left their spoor in the Alps, in Scandinavia, in Scotland, and in Ireland. In some few pictures only I could trace marks which seem to indicate a former extension of glaciers which exist. Captain Senior, who made the pictures, said that old glacier-marks *extend only a few miles from the ice in this region.* The surveyors who mapped the ground confirmed what I saw and heard. The Ganges glaciers and others in this region hang about the steep broken edges of great deep basins; and there is nothing to show that glaciers ever filled these basins, as European hollows were filled of old. Opposite to the Ganges there are no signs of that Glacial period to which European ice-marks are usually attributed." Again, "I crossed the Jumna, the Sutlej, and the Bias, about fifty miles from the hills. I saw no glaciated stones in the plains or near the banks of these three great rivers, all three rising among glaciers. There is nothing at the foot of the Himalayas here comparable to the glacial débris of Lombardy or the erratics of the American plains" (*id.* p. 114). "The Ravee (within sight of the Kashmir hills) rises among glaciers; but there is nothing like glacial work opposite to this great river-basin in the plains. In the Kangra valley there was no sign of a great glacier passing along the base of the Sutlej valley from east to west. Such a glacier, if it ever existed, must have left a conspicuous mark. So far as I have been able to learn from surveyors, geologists, travellers, photographers, and photographs, there are no marks of a big glacier in the Sutlej valley so far as it has been explored, but existing glaciers are close at hand" (*id.* p. 115).

In regard to the famous deposit of rounded stones in this valley, about which so much has been written and said, the same acute and experienced observer writes that "at first sight these stones by their great size suggested glacial action. They have been described as erratics, and the deposits in which they occur as 'moraines' of the Glacial period. I therefore sought carefully, but I could find none of the known marks. The Kangra big stones are all smoothed, dinted, and rounded; the biggest are next to the range. The size decreases as the distance increases, and the slopes grow less. They are not arranged like moraines at Turin or elsewhere, but spread like stuff of the same kind at the foot of the Pike's Peak in America, and at the end of the Dariel Pass in the Northern Caucasus. The deltas to which these trains of big stones belong all spread like fans from the jaws of deep, steep ravines near high, steep hills, and they are all washed and rolled by floods of water. . . . ."

At Dhada, a rest-house at the foot of the high range, "a gravel-

pit has been described by a very experienced geologist as one of the Kangra moraines. The solid rock under the loose stuff was newly laid bare. It is *not* glaciated. The whole of the stuff was sorted by running water, and the big stones strewed on the top evidently are the largest and heaviest in an old river deposit laid bare by late rains which have washed away smaller stuff. There was no moraine stuff in the section, no clay, and no scratched stones anywhere."

Mr. Campbell is most emphatic in his conclusion that the Himalayas present us with no evidence of a Glacial period. Glaciers exist there, and may have been larger. "While," he says, "Scandinavian and Alpine ice has shrunk by many meridian degrees, old Himalayan glaciers have left no mark within a few miles. It seems as reasonable to account for the length of an icicle by a Glacial period, as to summon that cause to account for any extension of Indian ice of which I was able to obtain proofs, from maps and surveyors, geologists and papers, photography and photographers, and travellers" (*id.* p. 118).

(*To be continued in our next Number.*)

II.—Notes on some Fish-remains from the Lower Tertiary and Upper Cretaceous of Belgium, Collected by Monsieur A. Houzeau de Lehaie.

By Arthur Smith Woodward, F.G.S., F.Z.S.

(PLATE III. Figs. 1–17.)

SOME time ago the writer was favoured by Monsieur A. Houzeau de Lehaie with the opportunity of studying his extensive collection of teeth and other remains of fishes from the Bruxellian Eocene, near Brussels, and the "Craie brune phosphatée de Ciply," near Mons. Monsieur Houzeau has generously presented a fine series of these fossils to the British Museum, and the following notes are based upon the collection.

I. The Fish-fauna of the Bruxellian Eocene.

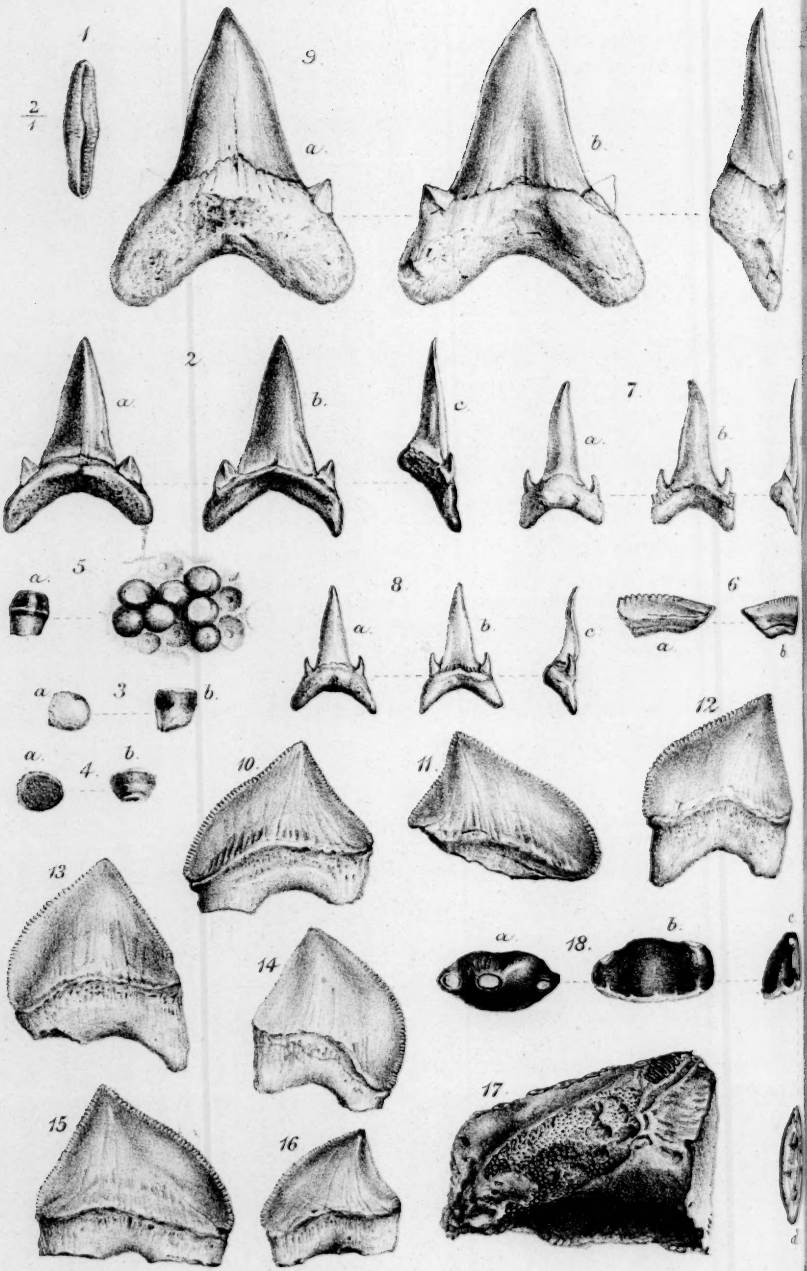
Like the contemporaneous Bracklesham Beds in England, the Bruxellian Sands of Woluwe St. Lambert, near Brussels, yield only very fragmentary remains of fishes. These have been studied more especially by M. H. Le Hon[1] and Dr. T. C. Winkler;[2] and MM. P. J. Van Beneden[3] and L. Dollo[4] have contributed additional notes.

[1] H. Le Hon, "Préliminaires d'un Mémoire sur les Poissons Tertiaires de Belgique" (1871).

[2] T. C. Winkler, "Mémoire sur des Dents de Poissons du Terrain bruxellien," Archiv. Mus. Teyler, vol. iii. (1874), pp. 295–304, pl. vii.; also *ibid.* vol. iv. (1876), pp. 16–48, pl. ii.

[3] P. J. Van Beneden, "Recherches sur quelques Poissons fossiles de Belgique," Bull. Acad. Roy. Belg. [2], vol. xxxi. (1871), pp. 153–179. Also "Notice sur un nouveau Poisson du Terrain bruxellien," *ibid.* vol. xxxv. (1873), pp. 255–259, with plate (*Homorhynchus bruxelliensis*).

[4] L. Dollo, "Première Note sur les Téléostéens du Bruxellien (Eocène moyen) de la Belgique," Bull. Soc. Belg. Géol. etc. vol. iii. (1889), Proc.-Verb. pp. 218–226 (*Arius Egertoni*).



Berjeau & Highley del. et lith. Hanhart

1-17. BELGIAN EOCENE AND CRETACEOUS FISHES.
18. DENTAL CROWN OF BOTTOSAURUS BELGICUS, sp. nov.

Several of the original determinations of the fossils were based upon insufficient comparisons, and have subsequently proved erroneous; and the examination of M. Houzeau's collection now enables the present writer to confirm and extend the revision commenced by recent authors.

ELASMOBRANCHII.

Cestracion Duponti, Winkler. Pl. III. Fig. 1.

1876. *Cestracion Duponti*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. p. 17, pl. ii. figs. 1–3.

Some anterior prehensile teeth of *Cestracion* have already been described and named *C. Duponti* by Dr. Winkler; and it is interesting to find in M. Houzeau's collection one of the crushing teeth so characteristic of the middle portion of each ramus of the jaw in this genus. The specimen measures 0·0095 in length and 0·003 in maximum breadth, and is shown from the coronal aspect, of twice the natural size, in Pl. III. Fig. 1. Having been discovered in the same formation and locality as the prehensile teeth, and agreeing with the latter in its comparatively small size, the new specimen may also be named *C. Duponti*, and thus adds somewhat to the scanty definition of the species. The tooth tapers gradually to its extremities, which are obtusely angulated, almost rounded; and there is a prominent median longitudinal keel, which rises to a blunt apex at the point of maximum breadth. The coronal surface is also coarsely rugose.

It is interesting to observe that the crushing tooth just described corresponds more closely with those of the Cretaceous species than with those of the existing forms; and it may be added that a similar tooth has already been recorded from the London Clay of Highgate Archway.[1]

Odontaspis elegans (Agassiz).

1843. *Lamna elegans*, L. Agassiz, Poiss. Foss. vol. iii. p. 289, pl. xxxv. figs. 1–5 (*non* figs. 6, 7), pl. xxxvii *a*. fig. 59 (*non* fig. 58).
1871. *Lamna elegans*, H. Le Hon, Prélim. Mém. Poiss. Tert. Belg. p. 12.
1875. *Lamna elegans*, A. Rutot, Ann. Soc. Géol. Belg. vol. ii. p. 34.
1876. *Otodus striatus*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. pp. 8, 24, pl. i. figs. 7–9.
1876. *Lamna elegans*, T. C. Winkler, *ibid.* p. 9.
1876. *Lamna elegans*, G. Vincent, Ann. Soc. Roy. Malacol. Belg. vol. xi. p. 123, pl. vi. fig. 4.
1876. *Otodus striatus*, G. Vincent, *ibid.* p. 125, pl. vi. fig. 2.
1880. *Lamna elegans*, T. C. Winkler, Archiv. Mus. Teyler, vol. v. p. 74.
1885. *Lamna elegans*, F. Noetling, Abh. Geol. Specialk. Preussen u. Thüring. Staaten, vol. vi. pt. 3, p. 61, pl. iv.
1889. *Odontaspis elegans*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus. pt. i. p. 361.

Typical teeth of this species occur, and it seems most probable that the teeth named *Otodus striatus* by Winkler are truly referable to the sides of the upper jaw of the same fish. Noetling has attempted to restore the dentition from the fossils of the Eocene of Samland, placing relatively low-crowned and broad compressed

[1] Catal. Foss. Fishes Brit. Mus. pt. i. p. 336.

teeth in the upper jaw,—an arrangement agreeing precisely with that of the existing species of *Odontaspis*. Notwithstanding recent criticisms,[1] we still venture to maintain that the form of the anterior teeth proves the species to be referable to the last-mentioned genus, and not to *Lamna*.

Oxyrhina nova, Winkler.

1876. *Oxyrhina nova*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. p. 22, pl. ii. fig. 8.

This species may be accepted as well defined.

Oxyrhina Desori, Agassiz.

1843. *Oxyrhina Desorii*, L. Agassiz, Poiss. Foss. vol. iii. p. 282, pl. xxxvii. figs. 8–13.
1885. *Oxyrhina xiphodon*, F. Noetling, Abh. Geol. Specialk. Preussen u. Thüring. Staaten, vol. vi. pt. 3, p. 50, pl. iii.
1889. *Oxyrhina Desorii*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus. pt. i. p. 382.

Some broad upper lateral teeth of this species occur in M. Houzeau's collection, and resemble those figured by Noetling (under the name of *Oxyrhina xiphodon*) from the Samland Eocene.

Lamna verticalis, Agassiz. Pl. III. Fig. 2.

1843. *Lamna* (*Odontaspis*) *verticalis*, L. Agassiz, Poiss. Foss. vol. iii. p. 294, pl. xxxvii *a*, figs. 31, 32.
1874. *Otodus minutissimus*, T. C. Winkler, Archiv. Mus. Teyler, vol. iii. p. 297, pl. vii. fig. 2.
1876. *Otodus parvus*, T. C. Winkler, *loc. cit.* vol. iv. p. 7, pl. i. figs. 5, 6.
1876. *Otodus minutissimus*, T. C. Winkler, *ibid.* p. 23.
1880. *Odontaspis mourloni*, T. C. Winkler, *loc. cit.* vol. v. p. 77, figs. 1, 2.
1883. *Lamna* (*Odontaspis*) *verticalis*, W. Dames, Sitzungsb. k. preuss. Akad. Wiss. Berlin, pt. i. p. 145, pl. iii. figs. 8–10.
1886. *Odontaspis minutissimus*, F. Noetling, Sitzungsb. naturf. Freunde Berlin, p. 16.

The large series of teeth of this species in M. Houzeau's collection seems to justify the above synonymy suggested by Prof. Dames. The form and proportions of the anterior teeth are characteristic of the true *Lamna*; and a typical lateral tooth is shown, of the natural size, in Pl. III. Fig. 2.

The type specimens of *L. verticalis* are stated by Agassiz to have been obtained from the London Clay of Sheppey, but the present writer has not been able to identify teeth of this form from any British Eocene deposit.

Lamna Vincenti (Winkler).

1876. *Otodus Vincenti*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. p. 25, pl. ii. figs. 9–10.

The teeth of this species exhibit no characters by which they can be separated from those of the true *Lamna*. They are well characterized by Winkler, though a reference might have been made to the supposed species, *Lamna compressa* of Agassiz. The latter comprises teeth of very similar proportions but distinguished by the form of

[1] J. W. Davis, Trans. Roy. Dublin Soc. [2], vol. iv. (1890), pp. 373, 398.

the lateral denticles; and there cannot be much doubt that most of these fossils are referable to the upper jaw of *Lamna macrota*.

Ginglymostoma thielense (Winkler).

1874–76. *Plicodus thielensis*, T. C. Winkler, Archiv. Mus. Teyler, vol. iii. p. 301, pl. vii. fig. 5, and *ibid.* vol. iv. p. 20.
1886. *Ginglymostoma thielense*, F. Noetling, Sitzungsb. Ges. naturf. Freunde Berlin, p. 14, figs. 2, 3.

The teeth described under this specific name exhibit all the characters of *Ginglymostoma*, as already noted by Noetling.

Scymnus trituratus (Winkler).

1874. *Corax trituratus*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. p. 27, pl. ii. fig. 13.
1879. *Scymnus trituratus*, J. Probst, Württ. Jahresh. vol. xxxv. p. 176.
1886. *Scymnus trituratus*, F. Noetling, Sitzungsb. Ges. naturf. Freunde Berlin, p. 17.

Some very small Bruxellian teeth are indistinguishable in shape from those of the existing *Scymnus*, and may thus be regarded as pertaining either to this genus or to a closely allied form at present undetermined.

Squatina, sp.

A tooth of *Squatina* occurs in M. Houzeau's collection, but cannot be regarded as sufficient for specific determination. It is less robust than the teeth of the same genus from the Heersian Beds,[1] and similarly differs from a Belgian Pliocene tooth described by Le Hon.[2]

Cœlorhynchus rectus, Agassiz.

1784. "Pétrification inconnue," Burtin, Oryctogr. Bruxelles, pl. vi. figs. A–E.
1844. *Cœlorhynchus rectus*, L. Agassiz, Poiss. Foss. vol. v. pt. i. p. 92 (name only).
1850. *Cœlorhynchus*, F. Dixon, Foss. Sussex, p. 112, pl. x. figs. 14–17, pl. xi. fig. 26.
1871. *Cœlorhynchus rectus* and *C. Burtini*, H. Le Hon, Prélim. Mém. Poiss. Tert. Belg. p. 14; also P. J. Van Beneden, Bull. Acad. Roy. Belg. [2], vol. xxxi. p. 500.

No specific differences between *C. Burtini* and the typical *C. rectus* have been pointed out, and they may be regarded as pertaining to one and the same form.

TELEOSTOMI.

Lepidosteus, sp.

1874. *Trichiurides sagittidens*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. p. 31, pl. ii. figs. 22, 23.
1883. "*Lepidosteus*-verwandter Ganoid," Hilgendorf, Zeitschr. deutsch. geol. Ges. vol. xxxv. p. 670.

As already recognized by Hilgendorf, the teeth described by Winkler under the name of *Trichiurides* are indistinguishable from those of *Lepidosteus*. Numerous teeth, head-bones, scales, and

[1] *Trigonodus primus*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. (1876), p. 14, pl. i. figs. 18–21.
[2] *Scaldia biforis*, H. Le Hon, Prélim. Mém. Poiss. Tert. Belg. (1871), p. 7, with figs.

vertebræ closely resembling those of the latter genus are well known from several European Lower Tertiary formations; and a single vertebra has been recorded from the Bracklesham Beds.[1]

Pisodus Oweni, Owen. Pl. III. Figs. 3–5.

1844. *Pisodus Owenii*, L. Agassiz, Poiss. Foss. vol. ii. pt. ii. p. 247 (name only).
1845. *Pisodus Owenii*, R. Owen, Odontography, p. 138, pl. xlvii. fig. 3; also Cat. Foss. Rept. and Pisces Mus. R. Coll. Surgeons (1854), p. 167.

Numerous detached teeth occurring in the Bruxellian of Woluwe St. Lambert are identical with those of the peculiar dental armature described by Owen from the London Clay of Sheppey under the name of *Pisodus*. Two of these specimens are shown of the natural size in Pl. III. Figs. 3, 4, and a portion of the typical dentition from Sheppey is represented for comparison in Fig. 5. The teeth are rounded or irregularly angulated, while the superficial gano-dentine is thin and soon removed by wear. The greatest diameter of the tooth is at the base of the crown, and the hollow root tapers below to its point of attachment to the bottom of a socket in the supporting bone.

The affinities of *Pisodus* seem to have hitherto escaped recognition, but a fine skull from Sheppey in the British Museum (No. 39439) shows that in all essential cranial characters it is identical with the existing Elopine Clupeoid, *Albula*. The peculiar tritoral dentition occurs upon the parasphenoid bone, and is precisely similar to that of the last-named genus.

Ancistrodon fissuratus (Winkler).

1852. *Sargus*? *armatus*, P. Gervais (*errore*), Zool. et Pal. Franç., Explic. p. 5, pl. lxix. figs. 9, 10.
1852. *Sargus*? *serratus*, P. Gervais (*errore*), *ibid.* p. 2, pl. lxvii. fig. 8.
1874. *Corax fissuratus*, T. C. Winkler, Archiv. Mus. Teyler, vol. iii. p. 299, pl. vii. fig. 4.
1876. *Corax fissuratus*, T. C. Winkler, *loc. cit.* vol. iv. p. 12, pl. ii. figs. 11, 12.
1883. *Ancistrodon armatus*, W. Dames, Zeitschr. deutsch. geol. Ges. vol. xxxv. p. 664, pl. xix. fig. 2.

As pointed out by Dames the specimens named *Corax fissuratus* by Winkler are truly pharyngeal teeth of a teleostean fish, and may thus be assigned to the provisional "genus" *Ancistrodon*. They are identified by Dames with three teeth from the Nummulitic Series of the Dept. Aude and Cuise-la-Motte, erroneously associated by Gervais with teeth of *Sargus* and other genera under the names of *Sargus*? *armatus* and *Sargus*? *serratus*.

Phyllodus, sp.

1876. *Phyllodus Deborriei*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. p. 28, pl. ii. figs. 14–18.

Though undoubtedly referable to the typical *Phyllodus*, the pharyngeal dentition described by Winkler is too imperfectly known for specific determination.

[1] Woodward and Sherborn, "Catalogue of British Fossil Vertebrata" (1890), p. 111.

Cybium (?) sp.

1876. *Enchodus Bleekeri*, T. C. Winkler, Archiv. Mus. Teyler, vol. iv. p. 43, pl. ii. figs. 24, 25.

The complete dentition of the Cretaceous genus *Enchodus* being now known,[1] it is evident that the teeth named *E. Bleekeri* are incorrectly determined. These specimens doubtless pertain to a typical Scomberoid, and may be provisionally assigned to *Cybium*, which is already known to occur in the Lower Tertiaries elsewhere.

Sargus, sp.

A few anterior teeth exhibit so much similarity to those of the existing *Sargus*, that either this genus or *Lethrinus* may be recorded as occurring in the Bruxellian Fauna. The genus has already been determined by Agassiz[2] from the Eocene of Montmartre; and Gervais[3] figures some anterior teeth from the Nummulite-bearing beds of the Dept. Aude.

Trigonodon serratus (Gervais). Pl. III. Fig. 6.

1852. *Sargus? serratus*, P. Gervais, Zool. et Pal. Franç., Explic. p. 2, pl. lxvii. fig. 7 (*non* fig. 8).

Very broad cutting teeth much resembling the incisors of *Sargus* and its allies, are met with in several Tertiary formations; but they cannot be referred to any known existing genus, since they appear to have formed only a single pair in each jaw. Very similar teeth, though somewhat more robust, also occur in the Upper Cretaceous of Northern Africa, and are regarded as the type of an otherwise unknown genus *Stephanodus*, by von Zittel,[4] who states that they are associated with rounded and oval crushing teeth, probably referable to the inner part of the mouth of the same fish.

Several of these teeth occur in M. Houzeau's collection from the Bruxellian Eocene, and one example is shown, of the natural size, from the outer and inner aspects, in Pl. III. Fig. 6. The trenchant border of the crown is nearly parallel to its basal margin, but is much longer than the latter, which equals in length the comparatively small root to which the crown is firmly united. Each tooth meets its fellow of the opposite side in a narrow curved symphysis in front, and is produced posteriorly into an acute termination. The superficial gano-dentine is smooth, but the trenchant border is prominently and delicately crimped, the numerous vertical folds terminating in serrations, which soon become obliterated by wear. Some of these teeth, indeed, are worn down to short stumps, and it is interesting to observe that the oblique surface of abrasion first appears posteriorly.

An extremely worn tooth of the general form just described, from the Lower Tertiary of Piedmont, is regarded as the type of a genus

[1] Smith Woodward, "A Synopsis of the Vertebrate Fossils of the English Chalk," Proc. Geol. Assoc. vol. x. (1888), p. 315, pl. i. figs. 5, 6.

[2] L. Agassiz, Rech. Poiss. Foss. vol. iv. (1839), p. 168, pl. xviii. fig. 1.

[3] P. Gervais, Zool. et Pal. Franç. (1852), pl. lxix. figs. 14–16.

[4] K. A. von Zittel, Handb. Palæont. vol. iii. (1888), p. 298.

Trigonodon by Sismonda;[1] and a tooth specifically indistinguishable from those of the Bruxellian is made known by Gervais from Cuise-la-Motte under the name of *Sargus? serratus*. The Middle Eocene fish under discussion must thus be termed *Trigonodon serratus*. Whether the more robust and coarsely denticulated character of the teeth described as *Stephanodus* justifies the recognition of this latter genus must be determined by future discoveries of more satisfactory specimens.

The most elaborate list of the typical Bruxellian Fish-fauna hitherto published is that of MM. A. Rutot and G. Vincent, contributed to Mourlon's "Géologie de la Belgique" (1880), p. 168. In conclusion, it may therefore be of interest to revise this enumeration of species in accordance with the latest researches:—

ELASMOBRANCHII.

Pristis Lathami, Galeotti.
Squatina, sp.
Myliobatis toliapicus, Ag.
—— *Dixoni*, Ag.
Aetobatis irregularis, Ag.
Cestracion Duponti, Winkl.
Scymnus trituratus (Winkl.).
Ginglymostoma Thielense (Winkl.).
Odontaspis elegans (Ag.).
—— *cuspidata* (Ag.).
Oxyrhina Desori, Ag.
—— *nova*, Winkl.
Lamna verticalis, Ag.
—— *macrota* (Ag.).
—— *Vincenti* (Winkl.)
Carcharodon heterodon, Ag.
Galeocerdo latidens, Ag.
—— (? *Protogaleus*) *minor*, Ag.

CHIMÆROIDEI.

Edaphodon Bucklandi, Ag.

ICHTHYODORULITE.

Cœlorhynchus rectus, Ag.

TELEOSTOMI.

Lepidosteus, sp.
Pycnodus toliapicus, Ag.
Arius Egertoni (Dixon).
Pisodus Oweni, Owen.
Ancistrodon fissuratus (Winkl.).
Trigonodon serratus (Gerv.).
Sargus, sp.
Cybium (?) sp.
Brachyrhynchus solidus, v. Ben.
Homorhynchus bruxelliensis, v. Ben.
Phyllodus, sp.

The so-called *Trigonodus secundus*, Winkl., *T. tertius*, Winkl., and *Gyrodus navicularis*, Winkl., require further examination.

II. The Fish-fauna of the Danian of Ciply.

M. Houzeau's collection comprises teeth and other remains from two horizons in the Ciply series—the "Craie brune phosphatée" and the overlying *remanié* bed known as the "Poudingue de la Malogne." The latter is evidently derived, at least in great part, from the former, and its fish-remains are essentially the same. Seven species only seem to be worthy of special note.

ELASMOBRANCHII.

Scapanorhynchus rhaphiodon (Agassiz).

1843. *Lamna* (*Odontaspis*) *raphiodon*, L. Agassiz, Poiss. Foss. vol. iii. p. 296, pl. xxxvii *a*. figs. 12–16 (*non* fig. 11).
1889. *Scapanorhynchus rhaphiodon*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus. pt. i. p. 353.

As proved by the beautifully preserved species from the Upper Cretaceous of Mount Lebanon, it is impossible to determine the

[1] E. Sismonda, Mem. R. Accad. Sci. Torino [2], vol. x. (1849), p. 25.

species of *Scapanorhynchus* merely by isolated teeth; and the attempt made by the present writer in the work cited to assign limits to *S. rhaphiodon* is thus only provisional. However, teeth indistinguishable from those usually named *S. rhaphiodon* occur at Ciply, and the species may therefore be recorded.

It seems most probable that the teeth from Ciply described as *Odontaspis* ("*Lamna*") *elegans* by MM. Houzeau, Briart, and Rutot,[1] also pertain to *Scapanorhynchus*. The present writer has only seen the detached dental crowns, and they certainly bear much resemblance to those of the well-known Lower Tertiary species; but these are insufficient to establish as a fact the range of a species of Shark from the Danian to the Lower Miocene. Very similar teeth from France and the United States have also been described under the names of *Lamna Trigeri*[2] and *Lamna texana*.[3] The so-called *Lamna elegans* from the Upper Cretaceous of Scandinavia is proved to be erroneously determined by the circumstance that the inner face of the teeth is smooth.[4]

Odontaspis Bronni, Agassiz.

1843. *Lamna* (*Odontaspis*) *Bronni*, L. Agassiz, Poiss. Foss. vol. iii. p. 297, pl. xxxvii *a*. figs. 8–10.
(?) 1843. *Otodus serratus*, L. Agassiz, *ibid.* p. 272, pl. xxxii. figs. 27, 28.
1852. *Otodus* and *Lamna*, P. Gervais, Zool. et Pal. Franç. pl. lxxvi. figs. 6, 8.
1889. *Odontaspis Bronni*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus. pt. i. p. 360.
1890. *Odontaspis acuta*, J. W. Davis, Trans. Roy. Dublin Soc. [2], vol. iv. p. 387, pl. xxxviii. figs. 21–24.

This is a well-characterized species, so far as the dentition is concerned, occurring in the uppermost Cretaceous horizons of France, Holland, and Southern Scandinavia, and abundantly represented in the Lower Danian of Ciply. An allied form also seems to occur in the Oamaru System of New Zealand. The great interest of the species consists in the fact, that its teeth differ very slightly from those of *Odontaspis Rutoti* met with in the Lower Eocene both of Belgium and Kent. It thus affords another instance of the striking similarity existing between the latest Mesozoic and the earliest Tertiary fish-remains.

Odontaspis Houzeaui, sp. nov. Pl. III. Figs. 7, 8.

Teeth with slender, sharply-pointed crown and robust root; outer coronal face flattened, marked with numerous short vertical wrinkles at its base-line, which is more or less arcuate; inner coronal face smooth; a single pair of prominent, slender uncinate lateral denticles, usually with a rudimentary denticle externally; inner nutritive foramen of root not in groove, inconspicuous. Anterior teeth (Fig. 7) exhibiting well-marked sigmoidal curvature, the

[1] A. Rutot, "Note sur l'Extension de *Lamna elegans*, Ag., à travers les Terrains Crétacé et Tertiaire, Ann. Soc. Géol. Belg. vol. ii. (1875), p. 35.
[2] H. Coquand, Descript. Géol., etc., Départ. Charente, vol. ii. (1860), p. 98.
[3] F. Roemer, Kreidebild. von Texas (1852), p. 29, pl. i. fig. 7.
[4] J. W. Davis, Trans. Roy. Dublin Soc. [2], vol. iv. (1890), p. 398, pl. xl. figs. 11–17.

internal bulging of the root very prominent, and its branches meeting at an obtuse angle; sigmoidal curvature and internal bulging of root also retained in the more posteriorly situated teeth but less conspicuous.

The writer has not observed teeth of this form in any collection except that from the "Craie brune" of Ciply, and they are specifically named in honour of their discoverer.

Lamna crassa (Agassiz). Pl. III. Fig. 9.

1843. *Otodus crassus*, L. Agassiz, Poiss. Foss. vol. iii. p. 271, pl. xxxvi. figs. 29–31.
1854. *Otodus crassus*, V. Kiprijanoff, Bull. Soc. Imp. Nat. Moscou, pt. ii. p. 384, pl. ii. figs. 4–20.
1889. *Lamna crassa*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus. pt. i. p. 400.

A number of teeth in M. Houzeau's collection are indistinguishable from those of this species, and one fine example is shown of the natural size in Pl. III. Fig. 9. The occurrence of the species in the Lower Danian of Ciply is of some interest, since it is met with only in a much lower horizon (Cenomanian) in the more Eastern areas of Bavaria and Russia.

Corax pristodontus, Agassiz. Pl. III. Figs. 10–16.

1843. *Corax pristodontus*, L. Agassiz, Poiss. Foss. vol. iii. p. 224, pl. xxvi. figs. 9–13.
1889. *Corax pristodontus*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus. pt. i. p. 423.

The teeth described as *Corax pristodontus* have long been known to characterize nearly all Upper Senonian and Danian formations; but no discovery of a series of naturally associated teeth seems to have been hitherto recorded. M. Houzeau, however, has now met with fourteen teeth of this form in the "Craie brune phosphatée" of Ciply associated in such a manner as to leave little doubt that they pertained to a single mouth. Seven of the specimens are shown, from the outer aspect, in Pl. III. Figs. 10–16, and it is interesting to observe how constant are the specific characters of the teeth, notwithstanding their variations in shape. The root is large in each, the anterior margin of the crown exhibits its gibbous curvature, and the posterior margin is always either destitute of the notch so characteristic of other species or only feebly excavated.

CHIMÆROIDEI.

Elasmodus Greenoughi, Agassiz. Pl. III. Fig. 17.

1843. *Elasmodus Greenovi*, Sir P. Egerton, Proc. Geol. Soc. vol. iv. p. 156 (name only).
1843. *Elasmodus Greenoughii*, L. Agassiz, Poiss. Foss. vol. iii. p. 350, pl. xl. figs. 11–16.
1891. *Elasmodus Greenoughi*, A. S. Woodward, Catal. Foss. Fishes Brit. Mus. pt. ii. p. 90.

M. Houzeau has discovered in the "Poudingue de la Malogne" several fragmentary teeth of *Elasmodus* agreeing not only in specific characters but also in physical condition with the type specimens of *E. Greenoughi* in the British Museum. The locality and horizon of this species are thus demonstrated for the first time by the new

collection, and another genus of fishes common to the Upper Cretaceous and Lower Tertiary is made known. An imperfect left mandibular tooth, wanting the symphysis, is shown of the natural size from the oral aspect in Pl. III. Fig. 17. It exhibits the large punctate median tritor, the prominent laminated anterior outer tritor, and the series of small subdivisions of the posterior outer tritor.

TELEOSTOMI.

Acrotemnus subclavatus (Agassiz).

1844. *Pycnodus subclavatus*, L. Agassiz, Poiss. Foss. vol. ii. pt. ii. p. 198, pl. lxxii *a*. fig. 59.

1887. *Anomœodus subclavatus*, H. Forir, Ann. Soc. Géol. Belg. vol. xiv. p. 25, pl. i. fig. 1.

Numerous detached teeth seem to be referable to this Danian species of Pycnodont, for which we follow Mr. Lydekker[1] in adopting the generic name of *Acrotemnus* (Agassiz), that of *Cœlodus*[2] being preoccupied. When separating the species from *Pycnodus* under a new generic name, Forir overlooked the fact that the Agassizian arrangement of the Pycnodont fishes had been revised about thirty years previously by Heckel. The fine right splenial dentition figured by Forir is, however, an important specimen.

In conclusion, the species from the Lower Danian of Ciply represented in M. Houzeau's collection may be enumerated in a short list. Many more forms could doubtless be recognized if the remains were less fragmentary, and future discoveries of teleostean fishes especially will be awaited with interest.

ELASMOBRANCHII.

Squatina, sp.
Cestracion, sp.
Synechodus, sp.
Scapanorhynchus rhaphiodon (Ag.).
Scapanorhynchus, sp.
Odontaspis Bronni, Ag.
Odontaspis Houzeaui, A. S. Woodw.
Lamna appendiculata (Ag.).
Lamna crassa (Ag.).
Corax pristodontus, Ag.
Corax affinis, Ag.

CHIMÆROIDEI.

Elasmodus Greenoughi, Ag.

ICHTHYODORULITE.

Cœlorhynchus (?) *cretaceus*, Dixon.

TELEOSTOMI.

Acrotemnus subclavatus (Ag.).
Enchodus, sp.

EXPLANATION OF PLATE III.

FIG. 1. *Cestracion Duponti*, Winkler; coronal aspect of lateral tooth, twice natural size. Bruxellian Eocene, Woluwe St. Lambert. [P. 5921.]

FIG. 2. *Lamna verticalis*, Agassiz; tooth, inner (*a*), outer (*b*), and lateral (*c*) aspects. *Ibid.* [P. 5915 *a*.]

FIGS. 3, 4. *Pisodus Oweni*, Owen; two detached parasphenoid teeth, coronal (*a*) and lateral (*b*) aspects. *Ibid.* [P. 5924.]

FIG. 5. Ditto; portion of parasphenoid dentition, with detached tooth (*a*) in side view. Bracklesham Beds, Sussex. [38827.]

FIG. 6. *Trigonodon serratus* (Gervais); anterior lateral tooth, inner (*a*) and outer (*b*) aspects. Bruxellian Eocene, Woluwe St. Lambert. [P. 5926 *a*.]

FIGS. 7, 8. *Odontaspis Houzeaui*, sp. nov.; two teeth, inner (*a*), outer (*b*), and lateral (*c*) aspects. Lower Danian (Craie brune), Ciply. [P. 5830.]

[1] Nicholson and Lydekker, Manual Palæont. vol. ii. (1890), p. 984.
[2] J. J. Heckel, Denkschr. k. Akad. Wiss. Wien, vol. xi. (1856), p. 202.

FIG. 9. *Lamna crassa* (Agassiz); tooth, inner (*a*), outer (*b*), and lateral (*c*) aspects. *Ibid.* [P. 5833 *a*.]

FIGS. 10–16. *Corax pristodontus*, Agassiz; associated series of seven teeth, outer aspect. *Ibid.* [P. 5827.]

FIG. 17. *Elasmodus Greenoughi*, Agassiz; imperfect left mandibular tooth, inner aspect. Lower Danian (Poudingue de la Malogne), Ciply. [P. 5837.]

FIG. 18. *Bottosaurus belgicus*, sp. nov.; crown of hinder tooth, coronal (*a*), external or internal (*b*), anterior or posterior (*c*), and inferior (*d*) aspects. Lower Danian (Craie brune), Ciply. [R. 1802.]

Except Fig. 1, all the drawings are of the natural size. The specimens are in the British Museum, and the numbers in square brackets refer to the Register of the Geological Department.

III.—NOTE ON A TOOTH OF AN EXTINCT ALLIGATOR (*BOTTOSAURUS BELGICUS*, sp. nov.) FROM THE LOWER DANIAN OF CIPLY, BELGIUM.

By A. SMITH WOODWARD, F.G.S., F.Z.S.

(PLATE III. FIG. 18.)

AMONG the vertebrate remains discovered by M. Houzeau de Lehaie in the "Craie brune phosphatée" of Ciply, is the crown of a large tritoral tooth, of unusual form and somewhat difficult of determination. A study of the reptilian teeth from the New Jersey Greensand in the Philadelphia Academy of Sciences has, however, suggested to the writer a plausible explanation of the specimen; and a brief notice of its characters may perhaps lead to the discovery of more satisfactory evidence of the animal to which it pertains.

As shown by the figures (Pl. III. Figs. 18*a–d*.), which are of the natural size, the tooth is longer than its maximum breadth, tapering at the extremities, without a longitudinal keel, and covered by dense dark enamel, which is nearly smooth, exhibiting only a faint transverse rugosity. One extremity of the crown is more elevated than the other, and the median portion is slightly raised above both these points. At each of the three elevations the surface enamel is worn off, thus exposing the softer light-coloured dentine. In basal view (Fig. 18*d*) the dentine is shown to consist of two or three superposed cones.

There being apparently no piscine dentition with which such a tooth can be compared, it is necessary to refer to the Reptilia; and among these the posterior teeth of the Alligators seem to present the most striking resemblances. In the fossil Alligators of the Lower Tertiaries the short tumid crowns of the hinder teeth are often found detached from the root, while they differ only from the fossil now under discussion in their much smaller size, the absence of lateral eminences, and the presence of at least a short, feeble, longitudinal keel. In a supposed Upper Cretaceous Alligator, however, of which the type species is comparatively large, the posterior teeth agree much more closely both in size and form with the Ciply specimen; and it seems reasonable to predict, from an examination of this fossil, that good evidence of a member of the Alligator-group will eventually be found in the Upper Senonian or Danian of Western Europe. *Bottosaurus*, as the imperfectly known genus in

question is termed,[1] has hitherto been met with only in the Upper Cretaceous of the United States; and there is so much agreement between the teeth of the typical *B. Harlani* (Meyer)[2] of the New Jersey Greensand and the tooth now described, that the latter may be provisionally recorded as *Bottosaurus belgicus*. So far as the writer's observations have extended, this is characterized by the presence of a small eminence at each end of the dental crown, and the sharply-rounded—not keeled—form of its median longitudinal line.

IV.—Note on Specimens of Cherty Siliceous Rock from South Australia.

By George Jennings Hinde, Ph.D., F.G.S.

Some specimens of Cherty rock forwarded to England for determination some years since by Mr. H. Y. L. Brown, F.G.S., Government Geologist of South Australia, have lately been submitted to me for examination by my friend Dr. H. Woodward, F.R.S., and their structure, as shown in thin sections, seems to me sufficiently interesting to be recorded. The specimens in question are of a light- or yellowish-grey tint, with a waxy lustre, in some portions compact and in others minutely porous, which makes them light to the feel. The rock is hard, scratching glass readily, and there is no reaction with acid. Numerous negative casts of fossils are present in it, the most abundant are those of a foliate Polyzoön probably of the genus *Retepora*, but casts of small turreted Gasteropods and bivalve mollusca are also not uncommon. In all cases the original calcareous tests of these organisms have been dissolved and removed, leaving impressions of their form in the translucent siliceous matrix; in some instances the casts have subsequently been filled up by silica.

Thin microscopic sections of the rock show that minute angular quartz-grains are scattered throughout the cherty matrix, but the principal feature is the occurrence of detached sponge-spicules which in places are heterogeneously crowded together in the rock. These spicules are by no means well preserved; they are mostly fragmentary and in various stages towards dissolution. Where the process has extended furthest, the substance of the spicule has disappeared, and there is either an empty cast, or merely the axial canal of the spicule now infilled with a dark substance. In all parts of the rock-section the former presence of spicules can be detected, although it is only in certain places that the spicules themselves remain in their originally crowded condition. The matrix in which the spicules and quartz-grains are imbedded appears to be mainly of amorphous or opal silica, nearly entirely neutral to polarized light between crossed Nicols, and it is principally in the form of very minute globules or discs usually aggregated together

[1] L. Agassiz, Proc. Acad. Nat. Sci. Philad. 1849, p. 169.

[2] J. Leidy, Cretaceous Rept. United States (1865), p. 12, pl. iv. figs. 19–23; pl. xviii. figs. 11–14. For further references to *Bottosaurus*, see E. D. Cope, Vert. Cret. Form. West (Rep. U.S. Geol. Surv. Territ. vol. ii. 1875), p. 253.

Fig. 9. *Lamna crassa* (Agassiz); tooth, inner (*a*), outer (*b*), and lateral (*c*) aspects. *Ibid.* [P. 5833 *a*.]

Figs. 10–16. *Corax pristodontus*, Agassiz; associated series of seven teeth, outer aspect. *Ibid.* [P. 5827.]

Fig. 17. *Elasmodus Greenoughi*, Agassiz; imperfect left mandibular tooth, inner aspect. Lower Danian (Poudingue de la Malogne), Ciply. [P. 5837.]

Fig. 18. *Bottosaurus belgicus*, sp. nov.; crown of hinder tooth, coronal (*a*), external or internal (*b*), anterior or posterior (*c*), and inferior (*d*) aspects. Lower Danian (Craie brune), Ciply. [R. 1802.]

Except Fig. 1, all the drawings are of the natural size. The specimens are in the British Museum, and the numbers in square brackets refer to the Register of the Geological Department.

III.—Note on a Tooth of an Extinct Alligator (*Bottosaurus belgicus*, sp. nov.) from the Lower Danian of Ciply, Belgium.

By A. Smith Woodward, F.G.S., F.Z.S.

(PLATE III. Fig. 18.)

AMONG the vertebrate remains discovered by M. Houzeau de Lehaie in the "Craie brune phosphatée" of Ciply, is the crown of a large tritoral tooth, of unusual form and somewhat difficult of determination. A study of the reptilian teeth from the New Jersey Greensand in the Philadelphia Academy of Sciences has, however, suggested to the writer a plausible explanation of the specimen; and a brief notice of its characters may perhaps lead to the discovery of more satisfactory evidence of the animal to which it pertains.

As shown by the figures (Pl. III. Figs. 18*a–d*.), which are of the natural size, the tooth is longer than its maximum breadth, tapering at the extremities, without a longitudinal keel, and covered by dense dark enamel, which is nearly smooth, exhibiting only a faint transverse rugosity. One extremity of the crown is more elevated than the other, and the median portion is slightly raised above both these points. At each of the three elevations the surface enamel is worn off, thus exposing the softer light-coloured dentine. In basal view (Fig. 18*d*) the dentine is shown to consist of two or three superposed cones.

There being apparently no piscine dentition with which such a tooth can be compared, it is necessary to refer to the Reptilia; and among these the posterior teeth of the Alligators seem to present the most striking resemblances. In the fossil Alligators of the Lower Tertiaries the short tumid crowns of the hinder teeth are often found detached from the root, while they differ only from the fossil now under discussion in their much smaller size, the absence of lateral eminences, and the presence of at least a short, feeble, longitudinal keel. In a supposed Upper Cretaceous Alligator, however, of which the type species is comparatively large, the posterior teeth agree much more closely both in size and form with the Ciply specimen; and it seems reasonable to predict, from an examination of this fossil, that good evidence of a member of the Alligator-group will eventually be found in the Upper Senonian or Danian of Western Europe. *Bottosaurus*, as the imperfectly known genus in

question is termed,[1] has hitherto been met with only in the Upper Cretaceous of the United States; and there is so much agreement between the teeth of the typical *B. Harlani* (Meyer)[2] of the New Jersey Greensand and the tooth now described, that the latter may be provisionally recorded as *Bottosaurus belgicus*. So far as the writer's observations have extended, this is characterized by the presence of a small eminence at each end of the dental crown, and the sharply-rounded—not keeled—form of its median longitudinal line.

IV.—Note on Specimens of Cherty Siliceous Rock from South Australia.

By George Jennings Hinde, Ph.D., F.G.S.

SOME specimens of Cherty rock forwarded to England for determination some years since by Mr. H. Y. L. Brown, F.G.S., Government Geologist of South Australia, have lately been submitted to me for examination by my friend Dr. H. Woodward, F.R.S., and their structure, as shown in thin sections, seems to me sufficiently interesting to be recorded. The specimens in question are of a light- or yellowish-grey tint, with a waxy lustre, in some portions compact and in others minutely porous, which makes them light to the feel. The rock is hard, scratching glass readily, and there is no reaction with acid. Numerous negative casts of fossils are present in it, the most abundant are those of a foliate Polyzoön probably of the genus *Retepora*, but casts of small turreted Gasteropods and bivalve mollusca are also not uncommon. In all cases the original calcareous tests of these organisms have been dissolved and removed, leaving impressions of their form in the translucent siliceous matrix; in some instances the casts have subsequently been filled up by silica.

Thin microscopic sections of the rock show that minute angular quartz-grains are scattered throughout the cherty matrix, but the principal feature is the occurrence of detached sponge-spicules which in places are heterogeneously crowded together in the rock. These spicules are by no means well preserved; they are mostly fragmentary and in various stages towards dissolution. Where the process has extended furthest, the substance of the spicule has disappeared, and there is either an empty cast, or merely the axial canal of the spicule now infilled with a dark substance. In all parts of the rock-section the former presence of spicules can be detected, although it is only in certain places that the spicules themselves remain in their originally crowded condition. The matrix in which the spicules and quartz-grains are imbedded appears to be mainly of amorphous or opal silica, nearly entirely neutral to polarized light between crossed Nicols, and it is principally in the form of very minute globules or discs usually aggregated together

[1] L. Agassiz, Proc. Acad. Nat. Sci. Philad. 1849, p. 169.

[2] J. Leidy, Cretaceous Rept. United States (1865), p. 12, pl. iv. figs. 19–23; pl. xviii. figs. 11–14. For further references to *Bottosaurus*, see E. D. Cope, Vert. Cret. Form. West (Rep. U.S. Geol. Surv. Territ. vol. ii. 1875), p. 253.

so as to exhibit a microscopic botryoidal appearance, the globules or discs ranging from ·01 to ·03 mm. in diameter. This globular form of opal silica is similar to that which occurs in many of the sponge-beds of the Upper Greensand[1] in this country and there can hardly be any doubt that in this Australian Chert it is due, as in the Chert of this country, to the solution and redeposition of the organic silica of the sponge-spicules.

The spicules in the Australian rock are not sufficiently well preserved to indicate with certainty the sponges to which they belonged; the only forms recognizable are portions of long slender rod-like or acerate spicules from ·5 to 1·4 mm. in length, and ·02 to ·06 in thickness, and calthrop or four-rayed spicules similar to those in the genus *Pachastrella*, O. Sch. It seems probable that they are chiefly of Tetractinellid sponges.

The principal importance of this Chert is the evidence it affords of the origin of this rock in Australia from organic sources; in view of the fact that Chert in Australia has been definitely attributed to chemical deposition[2] merely, the evidence to the contrary is the more valuable.

The specimens were collected by Mr. Brown at Yorke's Peninsula, near Adelaide, and the beds are believed to be of Tertiary age, though, so far as I am aware, their particular horizon has not been ascertained.

V.—Woodwardian Museum Notes.

On Two Abnormal Cretaceous Echinoids.

By T. Roberts, M.A., F.G.S.

IN 1887 a quadri-radiate *Echinoconus* (*Galerites*) *subrotundus* from the Lower Chalk of Shudy Camps, Cambridgeshire, was presented to the Woodwardian Museum by J. Carter, Esq., F.G.S. The specimen is in a good state of preservation, but it has been subjected to a slight amount of crushing, and this has caused (1) the apex of the test to be pushed backwards to a very small extent, and (2) an abrasion of the antero-lateral border. It has the subconoidal form of the normal examples of this species, but is subquadrate in section, and this is due to the fact that only four ambulacral and four interambulacral areas are present, the fifth area of both kinds being completely wanting.

Both the ambulacral and interambulacral areas are relatively wider than those in a normal specimen of the same size, and the space of the areas that are wanting appears to be shared proportionately among the eight areas that are present.

The apical disc is compact and roughly rectangular; the outline of the individual plates is not clear, but the disc is seen to be composed of four perforated basals (genitals) and four perforated radials (oculars). Even the basal plate corresponding to the posterior unpaired interambulacral area is perforated, which in normal specimens is imperforate.

[1] Phil. Trans. vol. clxxv. pt. ii. 1885, p. 428.

[2] Hull and Hardman, Proc. Royal Soc. vol. xlii. (1887), pp. 304–310.

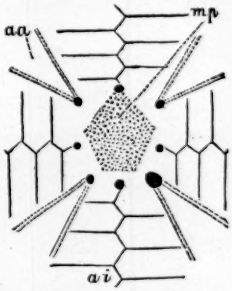
The parts missing from the test are those which lie on the left side of a line drawn through the middle of the anterior single ambulacrum and the posterior unpaired interambulacrum; but it is not possible to ascertain which of the paired areas of this side that are wanting, as the pores in the ambulacral plates round the peristome are indistinctly shown.

Meyer figures[1] an internal cast of *Galerites albogalerus* with six perfect ambulacral areas; but I am not aware of any abnormal example of *Echinoconus subrotundus* having been hitherto described.

Meyer also figures and describes a specimen of *Cidaris coronata*,[2] in which a complete ambulacral and interambulacral area is wanting; but the apical disc is not preserved, and I am unable to find out from his figure and description which of the paired or unpaired areas that were not developed.

In 1881 Prof. Jeffrey Bell described and figured[3] an abnormal specimen of *Amblypneustes formosus*, in which the abactinal surface shows a tetramerous arrangement of parts, but indications of pentamerism are shown on the actinal region. The apical disc, however, is normal, *i.e.* it is composed of ten plates. As in the *Echinoconus* under consideration, it is the left side of the test which has undergone change.

A somewhat similar abnormality, *i.e.* tetramerous abactinal and pentamerous actinal surfaces, has been described[4] by Philippi in *Echinus melo*, but in this case the apical disc was composed of four basals and four radials. Philippi and Bell state[5] that it is the left



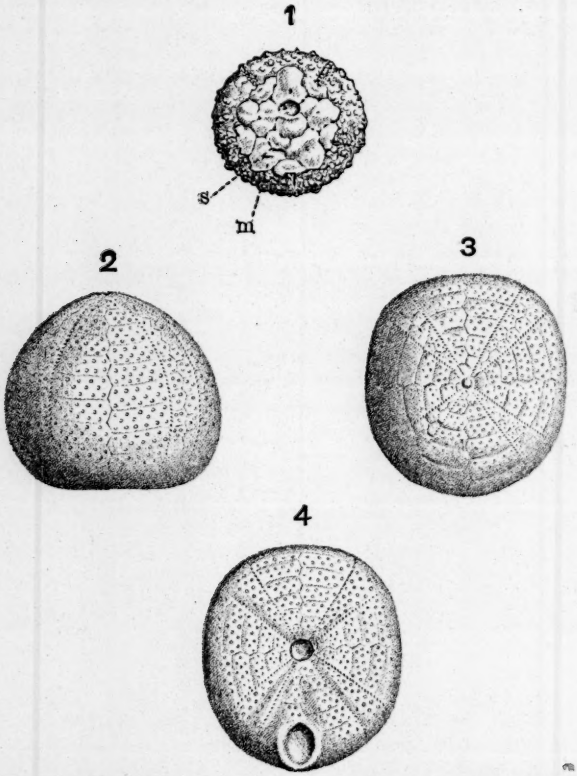
Apical disc of *Echinoconus subrotundatus* from Lower Chalk, Shudy Camps.
aa, anti ambulacrum; *mp*, madreporite plate; *ai*, anal interradius.

anterior area which has suffered change; but if the figure is correctly drawn, it is certainly the right posterior paired ambulacral area which has been only partly developed.

Mr. F. A. Bather[6] has recently described a tetramerous Crinoid, and he gives references to numerous examples of abnormality amongst the different groups of the Echinodermata.

[1] Nova Acta Physico-Medica Leop. Car. Acad. 18. 1 (1836), Tab. xiii. figs 5 7.
[2] *Ibid.* p. 287, Tab. xiii. figs. 1–5.
[3] Journ. Lin. Soc. (Zoology), vol. xv. (1881), p. 126, pl. v. figs. 1–3.
[4] Arch. für Naturges. iii. (1837) p. 241, pl. v.
[5] *Ibid.* p. 242 and *loc. cit.* p. 127.
[6] Q.J.G.S. vol. xlv. p. 149.

In the collection of fossils presented some time ago to the Woodwardian Museum by the late Montagu Smith, Esq., of Trinity College, Cambridge, is rather an interesting specimen of *Peltastes Wrightii*, from the Farringdon Beds of Farringdon. In most of its characters it agrees with the normal examples belonging to this species, but it differs from them in possessing twelve plates in the apical disc. The centro-dorsal plate, five radials, the unpaired and the two left and the right posterior basals are perfectly normal; but the right



1. *Peltastes Wrightii*, from Greensand, Farringdon. *m*, madreporic plate; *s*, supplementary plate.
2, 3, 4. *Echinoconus subrotundus*, Shudy Camps, Cambridgeshire.

anterior basal (madreporic) is smaller than any of the other basals, and its genital pore is situated relatively nearer the inner border of the plate than is the case in any other specimen which I have examined. Further, its inner border is somewhat concave, whereas in the ordinary examples it is straight. Interposed between the madreporite plate and the centro-dorsal, and bounded laterally by the left anterior and right posterior basals, is a distinct plate which is roughly

pentagonal in outline. The line separating this additional plate from the madreporite is not one of fracture, but is a true suture-line, and is marked by two pits precisely similar to those which are present on nearly all the suture-lines of the apical disc. In the suture-line between this extra plate and the centro-dorsal there is also a pit, but there are none in the suture-lines between it and the left anterior basal on the one hand, and the right posterior basal on the other. The plate in question is quite distinct from the peri-proctal plates of the recent *Salenia*, as it is separated from the periproct by the centrodorsal plate.

The relative size and outline of the madreporite plate, and the position of its pore, seem to indicate that the supplementary plate has either been separated from the madreporite plate at some early period of the life of this Echinoid, or that its presence has caused the madreporite plate to take the somewhat modified form described above.

The only abnormal form of *Peltastes Wrightii* which has hitherto been recorded is that which is figured by Wright,[1] where the centro-dorsal plate is stated to be wanting and the apical disc is described[2] as being composed of ten plates. The absence of the centro-dorsal plate in this specimen, however, is due to imperfect preservation, as the notches on the inner edges of the right and left posterior basals[3] abutting against the centro-dorsal clearly prove the former existence of a suture-line with the characteristic pittings; consequently the centro-dorsal plate must have been present at one time, but has since dropped out. Further, the raised rim or border which invariably surrounds the whole of the periproct in the normal specimen, is absent on the anterior half of the periproct in the specimen figured by Wright.

The presence of a centro-dorsal and a supplementary plate in the apical disc of the specimen under consideration, indicate a nearer approach to that of *Acrosalenia* than is shown by the normal examples, although the supplementary plate may not be homologous with any of the supplemental plates in the apical disc of *Acrosalenia*.

VI.—Note on a Greywether at Bayswater.

By Horace B. Woodward, F.G.S.

MY attention was directed last Christmas to the cellar of the King's Head, in Moscow Road, Bayswater. Some enlargement of the premises was required, and the base of the cellar was to be lowered. About a couple of feet beneath the old floor, the workmen came upon a block of stone, which resisted all their efforts to dislodge it: and no wonder! The stone proved to be a huge Greywether, of irregular quadrangular form, measuring 9 ft. 6 in. in length and also in breadth, and as much as 2 ft. 8 in. (possibly more) in thickness. A portion of one side appeared to be a joint-plane; otherwise the mass exhibited the ordinary contours of a concre-

[1] Cret Echin. pl. xxx. fig. 2.

[2] *Ibid.* p. 151.

[3] I am indebted to Mr. Gregory of the British Museum of Natural History for this information.

tionary block of sandstone. The rock itself was purely siliceous, and presented the familiar saccharoid aspect of a Wiltshire Greywether. Clean sand was found here and there in hollows on the surface of the stone, tending to prove that it had never been disturbed by human agency. It had evidently found a natural resting-place in the basement-portion of the Thames valley-gravel, close upon its junction with the London Clay; the lowest bed reached in the cellar being "stiff loam." These facts I was enabled to observe under the guidance of Mr. B. J. Capell (architect and surveyor).

In like situations near the base of the river-gravel, Greywethers have been found in many parts of the Thames Valley. Prof. Morris has noted their occurrence near Kew Bridge, and they have been observed at Ealing, in the Brent Valley, in the excavations for the Courts of Justice, and again at Ilford and Grays; but as Mr. Whitaker remarks the blocks occur somewhat rarely.[1] Nowhere else, so far as I am aware, has there been found in the Thames Valley deposits, a block so large as the specimen now discovered at Bayswater.

The transport of the larger blocks met with in the Thames Valley deposits has been attributed by Prof. Prestwich to river-ice, and to floods that imparted a torrential character to the river.[2]

Referring to the Greywethers found at Grays, Prof. Morris thought they "may have been originally derived from the Boulder-clay"; [3] and although Mr. Whitaker questions this explanation, there is evidence to show that such blocks were dispersed during the Glacial period over the country north of the Thames.

It is well known that over the Chalk tracts of Buckinghamshire, in the area between Princes Risborough and Beaconsfield, there is a considerable extent of brickearth with unworn flints, Greywethers, and occasionally pudding-stone. The brickearth in some places near Hampden and Bradenham is opened up for the sake of obtaining the stone, which is broken up and shaped into small paving-blocks, largely used at Aylesbury and other places.

This brickearth is very closely associated with the Clay-with-flints, and may be considered to be largely made up of the wreck of Eocene strata commingled with accumulations of Clay-with-flints. Somewhat similar beds occur on the Chalk tracts of the North Downs, to which attention has recently been directed by Professor Prestwich.

In South Buckinghamshire the brickearth in many places is associated with gravel, and this is largely made up of subangular flints (derived chiefly perhaps from subaerial accumulations), together with pebbles of flint from the Eocene beds, and quartzites. These deposits stretch into Hertfordshire, where we find patches of Boulder-clay. In my notes (made when mapping portions of the area in 1869) [4] I stated in reference to the Brickearth and Boulder-

[1] Whitaker, Geology of London, vol. i. pp. 330, 397, etc.
[2] Phil. Trans. vol. cliv. pt. 2, pp. 289, etc. [3] Geol. Mag. 1867, p. 64.
[4] See Whitaker, *op. cit.* pp. 288, 289; and Prestwich, Quart. Journ. Geol. Soc. vol. x. pp. 123, etc.

clay that one "apparently passes into the other." There is no evidence to suggest that the brickearth and gravel are newer than the main mass of Boulder-clay, but it is possible there may be lenticular masses of Boulder-clay in the brickearths and gravel, as is known to be the case in the neighbourhood of Hertford. Clear sections, however, were wanting in the neighbourhood of St. Albans, where I found it difficult to draw a boundary-line between the brickearth and the occasional remnants of Boulder-clay. In any case the evidence strongly favours the view that the gravels and brickearths (with Greywethers) belong to the Glacial period, and presumably to that portion of it to which the "Middle Glacial" deposits of East Anglia are assigned. Last year I saw at the Ipswich Museum a large block of Hertfordshire pudding-stone, which Dr. J. E. Taylor had procured from the Middle Glacial Sands of that neighbourhood. It was a block measuring 6 feet × 4 feet × 1 foot 4 inches, and weighing about 1½ tons. Floating-ice, in the shape of an iceberg, was, in Dr. Taylor's opinion, the means by which this block had been borne to its place of entombment.

The conclusion suggested by these facts is that, while the pudding-stone and Greywethers originated mainly in the Reading Beds and in the Bagshot Sands, many blocks were incorporated in the Drift during the Glacial period.

To the Glacial deposits, the Thames Valley gravel owes the greater portion of its constituents, the gravel was ready-made, and in pursuing its course and widening its bounds the river ever and anon may have torn away an accumulation in which one of the Greywethers was imbedded. The evidence, however, justifies no positive assertion with regard to the Bayswater Greywether. The nearest remnants of Glacial Drift are six miles distant; and it is quite possible that this particular block may have been derived directly from an outlier of Bagshot Sands, or it may have been left as a relic of Pre-glacial denudation near the spot where it has now been found.

VII.—Notes on Volcanic Paroxysmal Explosions, and the Causes of Volcanic Action.[1]

By Thomas Hart, F.G.S.

SINCE visiting the Volcanic region of Central and Southern Italy in the autumn of last year, I have been much exercised from time to time as to some of the conditions which produce, and sustain volcanic activity. It seems to be an undoubted fact that water coming into contact with highly heated rock is one of the most important requisites to produce, and sustain a volcanic eruption. The difficulty has been to explain how water is introduced.

In this connexion I would mention that the principal active volcanoes of the world are in close proximity to coast-lines, as Chimborazo, Vesuvius, or inland areas surrounded by the sea, as Hecla, Etna, and in New Zealand; also in a more special degree in such island groups as the Lipari, Krakatoa.

[1] Read at the British Association, Section *C* (Geology), Leeds, 1890.

Modern steam-engine boilers are now generally provided with "*Self-acting Injectors*" for supplying them with water in preference to the pumps formerly used, because the former have no working parts, and are not liable to derangement.

In the construction of these Injectors the elastic force of the steam in the boiler is utilized not only to force water into the boiler itself, which it does by imparting to it a considerable velocity, but when required to lift it ten or twenty feet in addition, as from a well.[1] The apparatus may often be seen at work upon most locomotive engines.

I would therefore suggest that this is probably a principle of the conservation of energy which comes into play during volcanic eruptions, the impetuosity of the current from below both carrying the water along with it from fissures in the rocks, and giving rapidity to the slow movement of percolation.

In addition to these forces, as the water ascends the pipe of the volcano, it will sooner or later (according to the pressure) be converted into steam, and produce a *blast* which will assist the upward current of molten rock, ashes, and vapour.

We often have illustrations of this, as when a locomotive discharges glowing ashes through the chimney brought from the furnace by an extra strong blast.

The water may be supplied either by rain percolation, by that of the sea, or by both combined, as well as through natural fissures; or in violent eruptions, through fissures produced by earthquakes which precede or accompany explosive volcanic paroxysms.

It may be well to refer to the account of the great eruption of Vesuvius in A.D. 79, given by Pliny the Younger. He says:—"There had been noticed many days before a *trembling of the earth*, which had caused, however, but little fear, because it is not unusual in Campania. But *that night it was so violent that one thought that everything was being not merely moved, but absolutely overturned.* It was found that the soundings of the Bay were altered,—an effect attributed to the falling masses, but probably in a great measure owing to an elevation of the sea-bed."

Therefore it would appear that the rocks may have been so disturbed by the preceding earthquake as to admit water from the Bay of Naples to the heated rock; and the engine of simple emission set to work that continued with such terrible results.

Further, it appears that water in contact with highly heated rock under enormous pressure may decompose into its elements, and form compounds which produce fuel to greatly intensify that heat.

We have ocular demonstration now in volcanic districts, as at the Solfatara near Naples, also at Vesuvius, that chemical decomposition of the rock below is active, as witnessed by the more or less pungent and complex emanations there given off, and by the beautiful crystals there formed from these various vapours.

[1] See "Injector," Encyclopædia Britannica, last edition, vol. 22, p. 500; also "Jet Pump," Encyclopædia Britannica, vol. 12, p. 476.

In the address by Mr. Anderson, President of Section G at the British Association Meeting held last year at Newcastle, as to the permanent supply of petroleum, he refers to the theory of Professor Mendelief that hydrocarbons in large quantities are forming now by the decomposition of metallic carbides through the instrumentality of the elements of water, deep in the bowels of the earth.

REVIEWS.

I.—Catalogue of the Fossil Fishes in the British Museum (Natural History). By Arthur Smith Woodward, F.G.S., F.Z.S. Part II. (1891.)

ONLY two years have passed since the publication of the first part of Mr. A. Smith Woodward's Catalogue of the Fossil Fishes in the British Museum, and now, in an almost incredibly short space of time, we have the second presented to us, a goodly volume of 567 pages and illustrated by sixteen plates. The scientific public, as well as the author, is to be congratulated on the progress of this work, which is calculated not only to be of the greatest value to all curators and keepers of museums in arranging and determining their collections, but to specialists themselves in prosecuting further researches in the same subjects. Mr. Woodward has exhaustively ransacked an immense amount of literature, which his visits to other museums, both British and foreign, have enabled him more thoroughly to appraise, so that as a book of reference the work is simply indispensable to those engaged in the study of fossil ichthyology. But more than this, the author has succeeded in boldly systematizing in a more satisfactory manner than has hitherto been attempted the more advanced notions of classification, which have been floating about in the minds and writings of those engaged in this and cognate studies; and he has done it in such a way as to impress his own individuality on the work.

As regards classification, Mr. Woodward has, as he acknowledges, derived much of his inspiration from Prof. E. D. Cope; but his greater opportunities for making himself acquainted with fossil forms has enabled him advantageously to modify the arrangements suggested by the "somewhat fluctuating" classifications of the American systematist, and some of the ordinal and subordinal terms which he has adopted from that source appear with their scope materially changed. We are not surprised to find our old familiar "Ganoidei" broken up, and the name finally discarded; for this we have long been prepared, and especially since the evidence of the evolutional continuity of the typical Ganoids with the Teleostei showed that the "Palæichthyes" of Günther could not be maintained. Like Cope, Mr. Woodward adopts as subclasses of Pisces the *Elasmobranchii*, *Holocephali*, *Dipnoi*, and *Teleostomi*, to which he adds the *Ostracodermi* (Cope), including the Cephalaspideans and Asterolepids, the former considered by Cope to be Agnatha and therefore not fishes, while the latter were once placed by the same author among the Ascidians, though lately he has pronounced them to be possibly Ostracoderms.

As regards the first four subclasses which possess a demonstrable endoskeleton in the paired limbs, Mr. Woodward has constructed an interesting table to express his view that in the evolution of their members these groups form parallel series. For, as has been pretty well known to palæichthyologists for some time back, the views of Balfour and Mivart that the ordinary Shark-limb is a more archaic and less specialized form than that of *Ceratodus* (archipterygium of Gegenbaur) is directly contradicted by palæontology. As Mr. Woodward well puts it, "If in accordance with the present teaching of embryological research, the paired limbs have been derived from lateral folds, the primitive condition of these appendages still remains undiscovered, and their evolution can only be traced from a comparatively advanced stage. All the most generalized early Palæozoic fishes hitherto met with exhibit two pairs of limbs of the paddle-like form termed archipterygium by Gegenbaur, and subsequent specialization has resulted in the gradual atrophy of these limbs usually with a concomitant development of the fringing dermal rays (actinotrichia)." Recently an interesting attempt has been made by Prof. Anton Fritsch to show that though Gegenbaur is undoubtedly right in holding the modern Shark-limb to be specialized from the archipterygium, yet the archipterygium itself may have been originally developed from a series of parallel rays.[1] And, as observed by Cope, some remains of this ancient fin-fold may possibly be indicated by the two ventral rows of spines in some Devonian Acanthodei.

The present part contains the remainder of the *Elasmobranchii*, the *Holocephali*, the isolated Ichthyodorulites, the *Ostracodermi*, the *Dipnoi*, and a part of the *Teleostomi*, including the Crossopterygii and the Acipenseroid families Palæoniscidæ and Platysomidæ.

Elasmobranchii.

Here Mr. Woodward follows Lütken and Fritsch in including the Acanthodei in this subclass, and as the want of evidence of any opercular apparatus renders it probable that the branchial clefts opened separately on the exterior, this may indeed be the best place to put them in the meanwhile. The remarkable deviation from the ordinary Elasmobranch type, exhibited by their paired fins, the author explains as due to extreme specialization (abbreviation) and his idea is that the Acanthodians "occupy the same position in the Elasmobranch phylum that is held at the present day by the Actinopterygians in that of Teleostomi." The account given of this group is one of the most interesting sections of the book, and he gives an original restoration of *Acanthodes Wardi*, Eg., which is a considerable improvement on the old and well-known figures of Roemer and Lütken (*A. Bronni*), though the orbit is too small, the peculiar fringe-like contour of the ventral fin is not given, and I am also inclined to hold that in representing the fish with prominent branchial "frills" after the manner of the recent *Chlamydoselache* the author is going beyond the legitimate limits of "restoration." The limitation of the family term *Acanthodidæ* to those genera with one dorsal

[1] "Fauna der Gaskohle," vol. iii. pt. i. pp. 44.

fin and spine is quite right, but I am not so certain that making two separate families *Ischnacanthidæ* and *Diplacanthidæ* out of those with two is equally justifiable. The only difference which Mr. Woodward gives between these two supposed families is the absence of "clavicular" bones in the former and their presence in the latter, and I, for one, am at present perfectly convinced that the element which he calls "clavicle" in *Diplacanthus* is identical with that which he considers as "basal cartilage" in *Acanthodes* and *Ischnacanthus*. It seems also somewhat inconsistent, that he should give in his definition of *Diplacanthus* "a pair of free spines situated between the pectoral and pelvic fins," while he persists in rejecting the genus *Mesacanthus*, which is distinguished from *Acanthodes* by the possession of that identical character!

Holocephali.

Next come the Holocephali with the single order Chimæroidei, which is divided into the four families of Ptyctodontidæ, Squaloraiidæ, Myriacanthidæ, and Chimæridæ. After these have been treated of we have a section upon the isolated Ichthyodorulites, some of which appertained, no doubt, to Chimæroids as well as to Elasmobranchs.

Ostracodermi.

We now enter a group of problematical organisms, concerning whose position, the analogy of recent forms affords us comparatively little clue; these are the *Cephalaspides* of Agassiz, *minus* the Coccosteans. The Coccosteans and Asterolepids were removed by M'Coy from Agassiz's Cephalaspides to form the order Placodermata, the remainder were divided by Lankester into two well-marked though allied groups, the Heterostraci and Osteostraci, exemplified by *Pteraspis* and *Cephalaspis* respectively. These two groups form the Ostracodermi of Cope, who considered them to be Agnatha, as no remains of lower jaw had been discovered in them; latterly he hinted that the Asterolepids which he had previously assigned to the Ascidians, as a group termed Antiarcha, might also belong here. This is the grouping now adopted by Mr. Woodward, but he takes the additional step of replacing these creatures among the fishes, justly remarking, "That there were no hard parts around the mouth and in relation to paired appendages capable of being preserved under ordinary conditions of fossilization seems to be satisfactorily demonstrated; but there is no justification for any further statement that jaws, pectoral and pelvic arches were absent." And certainly it seems difficult for any one to take into consideration the fact that the plates of *Pterichthys* are made of true bone, to look at its system of lateral sense-canals, as well as its scaly tail and fins, and yet to doubt that it is really a fish. Mr. Woodward's comparison of the structure of the Asterolepids and Ostracostei is of great interest, pointing out, as he does, the similarity of the position of the orbits and of the interorbital pineal plate, the resemblance of the scaly tail of *Pterichthys* to that of *Cephalaspis*, while he at the same time finds an analogy between the ventral shields of

some genera (*Didymaspis*, *Tremataspis*) and the ventral plates of *Pterichthys*.

In plates v. and vi. figures of the British species of *Pterichthys* are given, which are a great improvement on the old figures of Agassiz. In plate v. fig. 10, however, the central plate of the lower arm is lettered "anconeal," and a portion of the terminal one "central," the same mistake occurring also in pl. vi. fig. 4.

Dipnoi.

The Dipnoi are made to include two orders, Sirenoidei and Arthrodira. The Sirenoids, which are characterized by their archipterygial paired fins, and bodies covered with imbricating scales, are divided into the four families of Dipteridæ, Phaneropleuridæ, Ctenodontidæ, and Lepidosirenidæ; but this arrangement leaves room for revision, as *Uronemus* cannot be included in the Phaneropleuridæ, however much it resembles *Phaneropleuron* in external shape. Under Ctenodontidæ a somewhat serious error occurs in connexion with the description of a fine cranial shield of *Ctenodus cristatus*, which is also beautifully figured in plate iv. Here Mr. Woodward states (p. 253) that "the median series of bones is arranged exactly as in *Acipenser* and *Polyodon*." The arrangement does indeed resemble that in *Acipenser*, but *not* in *Polyodon*, in which there is no large median plate at the back of the shield, but two plates corresponding to the parietals of Palæoniscidæ and Chondrosteidæ, and like them being in contact in the middle line. Another mistake occurs on p. 234, in which, referring to what he gives as the "upper dental plates" of the same species (fig. 36, No. 2), he says that they are "somewhat inaccurately drawn, the oral aspect being in reality concave." But the fact is that they are quite accurately drawn, but unfortunately represent the *lower* and *not* the upper dental plates of the species in question. It is, however, fair to state that this error originated with the late Messrs. Hancock and Atthey, from one of whose plates the figure in question is copied.[1]

Coccosteus and its allies Mr. Woodward boldly places in the Dipnoi, where they form the order of Arthrodira, which he considers to bear "the same relation to the Sirenoidei that the Acanthodians seem to hold with respect to the primitive Elasmobranchs (Ichthyotomi) or the Actinopterygians with respect to the primitive Teleostomes (Crossopterygii)." This is an attractive solution of the question which has often been hinted at since the discovery of *Dinichthys* and its *Lepidosiren*-like teeth by Prof. Newberry. It may be so, and though I myself am one of those who have entertained the idea,[2] I scarcely feel yet that the matter is sufficiently ripe for definitely raising the Arthrodira beyond the rank of "*incertæ sedis*." It may be that they were autostylic, as Mr. Woodward thinks is so probable; but the absence of an osseous

[1] Ann. and Mag. Nat. Hist. [4], vol. vii. pl. xiv.

[2] "It seems therefore not unlikely that the *Placodermata* will eventually turn out to have been an aberrant group of loricated Dipnoi."—R. H. Traquair, in Proc. Roy. Phys. Soc. Edinburgh, vol. v. p. 159 (1879–80).

hyomandibular is no sure evidence that it did not exist in a cartilaginous condition. An important discovery is that of basal elements of a ventral fin in *Coccosteus*, which does not seem to have been archipterygial, but abbreviate, and though this in the minds of some would militate against these forms being classified with the Dipnoi, it is in accordance with Mr. Woodward's theory of their evolutional relationship to the Sirenoidei. It is satisfactory that the author gives no countenance to Prof. von Koenen's idea that a pectoral limb may yet be discovered in *Coccosteus decipiens*.

Teleostomi—Crossopterygii.

Mr. Woodward subdivides the Teleostomi into Crossopterygii and Actinopterygii; the former including the Rhipidopterygii of Cope, the latter the Podopterygii of the same author.

The Crossopterygii are divided into Haplistia, Rhipidistia, Actinistia and Cladistia. The Haplistia are not however the Haplistia of Cope, who established the order for the Dipnoan *Phaneropleuron*, for instead of it we have the problematical Tarrasiidæ, whose relationship to the Crossopterygii I have myself indicated in a recent paper, though I am far from believing that the question of its position is in any way settled, and indeed Mr. Woodward only places *Tarrasius* here provisionally. It certainly has an obtusely lobate pectoral fin, which I had the pleasure of pointing out to Mr. Woodward during a visit which he paid to Edinburgh in the spring of last year.

In the Rhipidistia Cope included only the Rhizodont genus *Tristichopterus*, which was thus removed from its own family, the other members of which he joined with the Holoptychiidæ and Osteolepidæ into another order, that of the Taxistia. Very properly Mr. Woodward fuses those two orders, for which he adopts the name Rhipidistia, containing the families Holoptychiidæ, Rhizodontidæ, Osteolepidæ and Onychodontidæ. This is indeed a natural group, for though the Holoptychii differ in some salient points from the other families here associated with them, they are also bound to them by obvious points of similarity which cannot be overlooked. Mr. Woodward adopts the view which I have so repeatedly maintained, that the Dendrodonts and Holoptychians are one and the same thing; but he does not clearly express the difference between the Dendrodont and Rhizodont type of tooth structure. Also when he says that in the Rhizodontidæ the vertical infoldings of the walls of the teeth are "comparatively few and simple," and in the Osteolepidæ only slightly infolded at the base, surely he cannot have examined sections of the base of the teeth in the larger genera of both families, such as *Rhizodus* or *Megalichthys*, in which, simple though the folds may be at the commencement of the external fluting, as they pass down to the root of the tooth they assume a complexity which, especially in *Rhizodus*, is absolutely wonderful as well as beautiful, though the vertical tubes formed by this infolding never form an interlacing network as in the Dendrodont type.

In the family Onychodontidæ is included the singular genus *Onychodus*, in which a scroll-like symphysial tooth-bearing element is present, and concerning which it is much to be desired that further details may soon be discovered.

The Actinistia (Cope) include the single family of Cœlacanthidæ, of which a concise account is given. Under Cladistia (Cope) we have the recent family of Polypteridæ, as yet unknown in a fossil state. Certainly *Polypterus* differs in many salient points from the known fossil Crossopterygii, and, as Mr. Woodward remarks, "The di- or tri-basal character of the pectoral fins in conjunction with other features may perhaps justify the recognition of this group as a distinct order."

Actinopterygii.

Under "Chondrostei" our author includes the Podopterygii of Cope (Acipenseridæ, Polyodontidæ, Chondrosteidæ), *plus* the Palæoniscidæ, Platysomidæ, Catopteridæ, and Belonorhynchidæ.

It is certainly satisfactory to myself that Mr. Woodward has adopted the placing of the Palæoniscidæ and Platysomidæ with the Sturgeons, which, since I proposed it in 1877,[1] has hitherto for the most part been either opposed or ignored. In his conception of the group, however, he does not place much stress on the peculiar heterocercy of the tail, but more on the excess in number of the dermal rays of the median fins over that of their supporting ossicles (baseosts), and hence he admits into it the semiheterocercal *Catopteridæ*, and the abbreviate-diphycercal *Belonorhynchidæ*, previously considered to belong rather to the Lepidostoid series. Certainly the Palæoniscus-like aspect of the dorsal and anal fins of *Catopterus* is extreme. In the brief definition of the Polyodontidæ, p. 424, he gives as a character that the cranial shield has a "median azygous series of bones," but I have already under Dipnoi pointed out that there is no median plate at the back of the skull in *Polyodon*, as in *Acipenser*, though further on, between the frontals, there commences a longitudinal series of four small ones extending to the extremity of the paddle-like snout, and which doubtless represent the single large median super-ethmoid of *Palæoniscus*.

In treating of the Palæoniscidæ the author gives a useful synopsis of the genera comprised in this extensive family, which he describes as "a provisional attempt to follow the lines of evolution." I quite agree with him that the obliquity of the suspensorium is a mark of specialization, and that such genera as *Canobius* and *Eurylepis* are in this respect more primitive than others such as *Cheirolepis* or *Pygopterus*, in which it is extremely oblique. So likewise is the tendency of the scales to pass from the rhombic to a circular and deeply imbricated form, as in *Cryphiolepis* and *Coccolepis*; in fact the scales of the former genus become so nearly absolutely cycloidal that when I first came upon them I referred them to *Cœlacanthus*. In a similar light is to be viewed the degeneracy of the squamation in *Phanerosteon*, in which the scales over the greater part of the body

[1] "Carboniferous Fishes" (Mon. Palæont. Soc.).

absolutely disappear; but whether the more advanced position of the dorsal fin in some cases than in others is also to be considered as a mark of specialization requires further consideration.

The Platysomidæ, which Mr. Woodward calls "Platysomatidæ" finish the volume, and are handled with the same care which characterizes the whole of the work. Of *Dorypterus* the author remarks that it is "here regarded as a highly specialized ally of the family destitute of squamation on the flanks." In this he is undoubtedly right, but it is much to be regretted that, owing to the great rarity of this remarkable fish, nothing definite is as yet known of its cranial structure.

It would be impossible within the limits of a review to enter into questions as to the retention or rejection of various genera and species. As regards the fishes of the Scotch Old Red Sandstone I am, however, pleased to find that Mr. Woodward acquiesces in the extensive slaughter of pseudo-species which I proposed in this MAGAZINE a little more than two years ago. These and other things too can only be discussed by the writers of future memoirs dealing specially with the matters concerned.

A word now as to nomenclature. I am sorry to see that Mr. Woodward adheres to the present fashionable craze of writing all specific names with a small initial letter, even when they represent the names of persons. It is really no compliment to any one to have a species called after him, if he is to find his name spelt in so grotesque a fashion.

Mr. Woodward, instead of the classically correct, but decidedly cacophonic "Osteolepididæ" and "Asterolepididæ," uses "Osteolepidæ" and "Asterolepidæ"—"from the point of view of euphony." Why then, instead of "Platysomidæ," does he write "Platysomatidæ," which sounds nearly equally badly, while the change seems to me more than wholly uncalled for? It is true that *σωμα*, a body, has for its genitive *σωματος*, but the name of the type genus of this family is not "*Platysoma*" but *Platysomus*, and though Agassiz in compounding this name used two Greek words, the latter of which was a neuter substantive, he made out of them, as he was quite entitled to do, a new Latin masculine word, and therefore "Platysomidæ" is perfectly correct.

On the same principle I devised some new generic names such as *Microbrachius*, *Euctenius*, *Cynopodius*, and I am curious to know why Mr. Woodward has altered the first of these into "*Microbrachium*." If it is because the Latin for "arm" is *brachium* and the Greek *βραχιων*, then surely to be consistent he ought to write not only *Platysoma*, but also *Gyracantha*, *Graphiura* and *Amblypterum!* for certainly in my Greek dictionary the words for *thorn*, *tail*, and *wing*, respectively, are *ἡ ἄκανθα*, *ἡ οὐρα*, and *τὸ πτερόν*.

The sixteen lithographic plates are from the accomplished pencil of Miss G. M. Woodward, and it is impossible to speak in too high terms of their excellence as well as works of art as illustrations of scientific fact.

R. H. TRAQUAIR.

II.—Notes on the Geology of Ayrshire. By James Lindsay, M.A., B.D., B.Sc., F.G.S. 8vo. pp. 31. (Glasgow, 1890.)

In this pamphlet the author gives a summary of what is known about the geology of Ayrshire, and points out many leading facts that are of general geological interest and significance. Prof. Lapworth's researches on the Girvan rocks naturally claim especial attention, and the various fossiliferous stages in these Ordovician and Silurian rocks are duly noted. The Ballantrae rocks have yielded a Graptolitic fauna believed to be of Arenig age, but many of the rocks so grouped may be of earlier age. Above them come the Girvan rocks ranging from Llandeilo-Bala to Wenlock, while rocks probably belonging to the Ludlow Series are also noticed. The Lower Old Red Sandstone yielding *Cephalaspis Lyelli*, and the Upper beds with *Holoptychius* and *Pterichthys*, are represented in Ayrshire; but the beds on the whole contrast strongly in their comparatively barren character with the older fossiliferous rocks. The author (quoting Dr. A. Geikie) mentions the occurrence in the heart of the Old Red Sandstone series of Arran, of marine limestone-bands containing Carboniferous Limestone fossils; thus proving that prior to the termination of the Upper Old Red Sandstone, the fauna of that Limestone already existed outside the area. Nevertheless we find a development of Calciferous Sandstones at the base of the Carboniferous Limestone; and this Limestone is represented with lower, middle, and upper divisions, underlying the Coal-measures. The lower limestone swells out to 100 feet thick, and is the most massive bed of limestone in any part of the Scottish Carboniferous system. The leading fossils of the divisions are mentioned, and in the central portion come the black-band ironstone and some coal-seams.

The Permian strata, the Volcanic rocks, and the Drift accumulations also receive due attention. Thus we may commend this little work to all who seek acquaintance with the geology of Ayrshire.

III.—Contributions to the Tertiary Fauna of Florida, with Especial Reference to the Miocene Silex-beds of Tampa, and the Pliocene Beds of the Caloosahatchie River. Part I. By W. H. Dall, A.M. (Trans. Wagner Free Inst. of Sc. of Philadelphia, Vol. III. (1890), pp. 1–178, 12 plates.)

This memoir deals almost exclusively with the Pulmonate, Opisthobranchiate and Orthodont Gasteropods of the Upper Tertiaries of Florida. The author states that he hopes it "will make a beginning in the direction of a better and more natural classification of our (American) Tertiary molluscs, and of a clearance of the ground of synonyms, erroneous identifications, and other misconceptions." Mr. Dall's knowledge of recent and fossil Gasteropods, not only of the American continent, but of Europe and other parts of the world, has been of immense service to him in dealing with the present subject, as is evinced by the astute criticisms with which the memoir is enriched.

The greatest interest, perhaps, centres round the *Volutidæ*, where the origin of the columellar plications, their obliquity, number and form, and the characters of the nuclei are set forth at great length; forming a most important contribution to our knowledge of the morphology of this group, and which cannot fail to become classical material. The author states: "The indications are pretty clear that from the Mesozoic *Fusidæ* are descended, on the one hand *Tudicla*, *Fulgur*, *Fasciolaria*, and *Latirus*; and on the other *Volutomorpha*, *Volutoderma*, *Volutilithes*, *Lyria*, *Voluta*, *Caricella*, *Scaphella*, *Aurinia*, *Turbinella* proper and *Vasum*."

Considering the extensive range of the monograph, there are very few slips. We may point out, however, that the sub-genus *Subularia*, Monterosato, 1884, should be substituted for *Leiostraca*, H. and A. Adams, 1853 (*non* Albers, 1850). The genus *Tritonium*, Link, 1807, should disappear, that name having previously been employed by Müller, 1776, for a different mollusc; whilst *Nassaria*, Link, 1807, *fide* H. and A. Adams, 1853 (*non* Duméril, 1806), should be replaced by *Hindsia*, Adams, 1850.

Ancillaria, Lamarck, 1810, is synonymous with *Ancilla*, Lamarck, 1799, and the latter name should therefore be preferred. *Tornatina*, Adams, 1850, should take the place of *Utriculus*, Brown, 1845 (*non* Schumacher, 1817). The name *Polygyra cereolus microdonta*, Dall, is barely in accordance with the rules of nomenclature.

The author is, notwithstanding, to be sincerely congratulated on the production of a monograph of such unquestionable value, the like of which has certainly never before appeared in the United States. We anxiously await the publication of Part II., which will contain descriptions of the remainder of the Gasteropoda, the Scaphopoda and the bivalves. G. F. H.

IV.—The Autobiography of the Earth. By Rev. H. N. Hutchinson, B.A., F.G.S. Small 8vo. pp. 290. (London, Edward Stanford, 1890.)

THIS little volume is a popular exposition of geology intended for the use of general readers, to whom ordinary text-books are "dry, uninteresting, and even quite unintelligible." Within the space of 300 pages all the principal features both of physiography and stratigraphy are discussed, beginning with the nebular theory and terminating with the advent of man; and, notwithstanding the brevity and condensation which the treatment of so vast a subject in such limited space entails, Mr. Hutchinson is to be congratulated on the manner in which he succeeds in converting bare statements of fact and theory into pleasant and entertaining gossip. One leading feature of the book is the care bestowed by the author in explaining the methods by which many of the broad conclusions of the geologist have been attained; while another feature tending to popularize the subject and render it intelligible is the manner in which the operations of the various geological agents are treated successively amid stratigraphical considerations, as the different rock-structures requiring explanation are encountered.

It is difficult for one accustomed to the literature of geology and palæontology to judge how far the present volume will meet the popular demand; but we are inclined to think that in some cases the use of imperfectly defined technical terms and expressions will present difficulties to the general reader. The occasional indiscriminate use of synonymous terms (*e.g.* Carboniferous Limestone and Mountain Limestone) without explanation also seems unfortunate; and it would be well to attend to these points in a subsequent edition. On the other hand, for a compilation extending over so wide a field the work before us is remarkably free from errors, and all the mistakes worthy of note seem to be confined to palæontological and zoological subjects. Brachiopods and Polyzoa are very far from being Mollusca, as the author regards them; and the origin of the name "Foraminifera" is inaccurately stated on p. 98. The Devonian "dicotyledon" (p. 86) admits of a more reasonable interpretation than that originally suggested by Sir William Dawson; and the Carboniferous fruit "migonocarpon" ought to be "trigonocarpon." Several Brachiopods are mentioned on p. 96 as if they were Corals; and the first appearance of "Sharks," as generally understood, is not in the Jurassic (p. 204), but in the Upper Silurian. European Cretaceous Mosasaurs are more numerous than the author supposes (p. 235); and the Eocene Snake, *Palæophis*, is far from being a Boa-constrictor (p. 242). There are also several misprints, such as *Hyperodopedon* for *Hyperodapedon*, *Notosaurus* for *Nothosaurus*, *Simoliophis* for *Cimoliophis*, and *Unitatherium* for *Uintatherium*. These, however, are small matters, and we only call attention to them in view of a second edition, which ought soon to be required. As a reliable and entertaining introduction to the subject of which it treats, the work is a valuable addition to popular scientific literature.

V.—A Bibliography of Palæozoic Crustacea from 1698 to 1889, including a List of North American Species and a Systematic Arrangement of Genera. By A. W. Vogdes. 8vo. pp. 177. Washington (U. S. Geol. Survey, Bull. No. 63, 1890).

MR. VOGDES' carefully compiled Bibliography and Catalogues of Palæozoic Crustacea are doubly welcome, when we remember the extraordinary carelessness of compilation and abundance of misprints in some recent publications of a similar nature which have reached us from America. Mr. Vogdes not only shows an intimate knowledge of his subject, but also his perfect competence to refer to a book accurately and fully. The whole work, indeed, bears evidence of a careful and painstaking endeavour to produce the best results possible, instead of a hasty scramble through such books as are to be found in the library of a minor town, and wholesale misquotations from others which the compiler has never seen and does not trouble to find.

There are very few misprints, and in reading his proofs Mr. Vogdes has had the assistance of Prof. U. P. James. The references are full; there is no irritating series of initial letters used in quotation: thus no doubt can be entertained as to the work referred to.

The Bibliography occupies the first 78 pages, the Catalogue of Trilobites from pp. 81–148, and the Catalogue of Palæozoic non-Trilobites [unfortunate word] pp. 151–177, a brief appendix of seven pages being included with the author's edition.

This Bibliography will be exceedingly valuable, and will, with the Catalogues, considerably lighten the labours of those who work in Palæozoic Crustacea and Arachnida.

It would be ungenerous to find fault with so careful a work, but we may perhaps be permitted to refer to two points in the hope that Mr. Vogdes will consider them in his second edition. In the first place, when a species is referred to more than once, it seems desirable, instead of reprinting the name itself, to substitute a ———, and at the same time to represent the name of the original author in a similar manner. There could then be no doubt as to whether or no the same specific name had been used by two authors for different forms. Take for instance *Leperditia alta*, Conrad sp. Five authors have referred to *alta*, and though the specialist may know there is only one *L. alta*, doubt cannot fail to oppress the mind of the novice. It would be absolutely clear if three dashes, representing respectively generic, trivial, and authors' names, were used before the name of the authors referring to the particular species, thus ——— ——— —— Vogdes, Bibl. Pal. Crust., etc. In the second place, it would have been better had Mr. Vogdes enumerated separately the new generic and specific names that he has suggested in his Catalogue, as in a work of this kind they are especially liable to be overlooked. C. D. S.

VI.—On an Erect Tree-stump with Roots, from the Coal of Piesberg, near Osnabrück. By H. Potonié.

Der im Lichthof der Königl. geologischen Landesanstalt und Bergakademie aufgestellte Baumstumpf mit Wurzeln aus dem Carbon des Piesberges. Von Herrn H. Potonié. [Jahrbuch der Königl. preuss. geologischen Landesanstalt, 1889, s. 246.]

THE "tree stump with roots" which forms the subject of the present notice was found in the Piesberg Colliery near Osnabrück standing in its natural position at right angles to the plane of the bedding.

Several specimens have been found in the same locality. Of the two largest specimens one is now in the Osnabrück Museum, the other, described in detail by Potonié, in the Berlin Bergakademie.

The latter specimen is displayed to advantage in the Berlin Museum, as one sees from the excellent photograph in Potonié's paper, and reminds one of the giant *Stigmaria* recently added to the Owens College Museum, Manchester. In the Berlin *Stigmaria* there is much more of the stem preserved than in the Manchester example; in neither specimen can one determine to what species the tree should be referred, nor indeed with any certainty fix the genus, whether *Lepidodendron* or *Sigillaria*. From such surface markings as are preserved on the roots Potonié names the Stigmarian portion *Stigmaria ficoides* (Brong.), var. *inæqualis* (Göpp.)

In the Berlin specimen the height of the tree stump, measured from the first dichotomy of the root, is 1·30 metres (4·26 feet). In the famous Dixon Fold fossils, casts of which are preserved in the Manchester Museum, the stem measures in one case 2ft. 6in., in the other 6ft. 6in.[1]

To compare the roots. In the Clayton specimen (Owens College Museum) the roots attain a greater length than in the Berlin specimen: in both cases the several subdivisions of the dichotomous branches are fairly uniform in size, in the latter specimen the longest terminal root branch measures 2·20 metres (7·21ft.), in the former the longest ultimate branch has a length of 12ft. 8in. Potonié compares the dichotomous branching of *Stigmaria* to that of *Isoetes*. Photographs are given of such portions of the stem where the carbonaceous covering shows any surface-markings; these occur in the form of more or less spirally arranged spindle-shaped prominences, which represent the points of exit of the primary medullary rays from the wood into the cortex.

Attention is called to a well-marked longitudinal striation ("Langsstreifung") on the surface of the carbonaceous layer; this is regarded by Potonié as the expression of the elongated elements of the wood. For this striation, which is seen not infrequently on decorticated *Lepidodendra* and *Sigillariæ*, the term "Holzstreifung" is proposed.

A. C. Seward.

VII.—The Maltese Islands, with Special Reference to their Geological Structure. By John Murray, LL.D., F.R.S., F.R.S.E. Scottish Geographical Magazine, September, 1890, Geological Map and Sections, Two Plates and Woodcuts.

THE Scottish Geographical Magazine is fast becoming one of the most important geological serials published in this kingdom. This paper by Dr. Murray is only one of many valuable contributions to geology which have been published in its pages. The Geology of Malta was sadly in need of some one to collect together the previous observations of others, and to add those of practical experience. Dr. Murray has done this work well, and by appending a fairly complete bibliography has earned the thanks of all geologists, as well as those of the student of deep-sea deposits. The first eleven pages (pp. 449–459) of the paper are occupied with a brief history of the islands (Malta, Gogo, Comino, Cominotto, and Filfola), geographical, climatal, botanical, zoological, historical, and economic; the remaining pages (459–488) are devoted to the geology and marine deposits off the coasts. The rocks are all of Tertiary age, and have been variously classed as Eocene, Oligocene, and Miocene by different observers. About 1150 feet of strata are exposed, each of which yields an interesting fauna, while numerous remains of the later inhabitants of the islands are found in the fissures which exist in various localities. The deposits are treated in order, and appended to each is an important and full list of the Foraminifera, the most abundant organisms in the rocks, supplied

[1] A monograph on the Morphology and Histology of *Stigmaria Ficoides* by W. C. Williamson, LL.D., F.R.S. (Palæontographical Soc. vol. for 1886, London).

by Frederick Pearcey. These lists are exceedingly interesting in connexion with the recent Foraminiferal fauna of the Mediterranean. Analyses of the different rocks are given, and the probable depth of water in which they were deposited is discussed. Remarks on the economic value of the rocks as building material, and interesting notes of a practical nature in addition to this subject, are supplied by C. H. Colson. The various caves that have yielded vertebrate remains are catalogued, and the paper closes with a description of the recent marine deposits in process of formation off Malta, and a long discussion as to the origin of the rocks and soils. The plates contain representations of four slices of Foraminiferal Limestones from Malta. The map and sections are in every way excellent, and a copy of these has been framed and hung up in the Fossil Mammalian Gallery of the Natural History Museum, close to Admiral Spratt's, and Dr. Leith Adam's Collections of Pigmy Elephant-remains from Malta, and forms one of many such valuable aids to the student in the Palæontological Department. C. D. S.

REPORTS AND PROCEEDINGS.

Linnæan Society.

Jan. 15, 1891.—Dr. P. H. Carpenter, F.R.S., read a paper on "Some Points in the Morphology of the Cystidea."

A large number of the Cystidea may be compared with dicyclic Crinoidea more directly than has hitherto been supposed.

Group I. has a generally six-rayed structure; Exx. *Caryocrinus, Hemicosmites, Juglandocrinus, Cordylocrinus.* Here are three circlets of plates, viz. four infrabasals, two of which are double plates, six basals, and six radials, with two or three interradials enclosed within the radial circlet. The summit-plates or orals also are comparable with those of Crinoidea, though differing in number; thus *Caryocrinus* has one central plate and five others around it, corresponding to the one central and four surrounding plates of a Crinoid: the central plate in either case represents the posterior oral. Even the number is sometimes the same as in a Crinoid; thus, though *Caryocystis granatum* has six rays, *C. testudinarius* (v. Buch. *non* His.) has five; while there are but four in other species.

Group II. has a five-rayed structure; Exx. *Lepadocrinus, Apiocystis, Prunocystis, Echinoencrinus* (Forbes *non* v. Meyer). Here are four infrabasals, one of which is double, five basals, five radials and five interradials (?). Sometimes an interradial is missing, e.g. *Cystoblastus* (l. post.), *Pseudocrinus* (r. antr.). Some genera (*Apiocystis, Callocystis*) have only four ambulacra. The plates in this group may still be designated by the numbers applied to them by Forbes: thus 1–4 are infrabasals, 5–9 basals, 10–14 radials, 15–18 or 19 interradials. The homology of Nos. 10–14 with radials is corroborated by *Cystoblastus*, in which these five plates have a deep fissure for the ambulacra. There is moreover symmetry in the disposition of the pore-rhombs, which generally occur on plates 1 & 5, 14 & 15, 12 & 18.

Variations from the simple types occur. Sometimes two of the radials sink into the basal circlet, e.g. *Callocystis*, while in *Glyptocystis*

and *Cystoblastus* some or all of the interradials enter the radial ring. *Glyptocystis* affords a transition to such flattened forms as *Pleurocystis*. *Homocystis*, *Lichenoides*, *Macrocystella* and some other types have three regularly alternating series of plates.

Orals, homologous with those of Crinoidea, are to be distinguished: (α) five of equal size, e.g. *Cyathocystis* of Russia; (β) five of unequal size, the posterior being the larger, e.g. *Glyptosphæra Leuchtenbergi* and *Sphæronis*; (γ) none in adult, probably resorbed, e.g. *Ascocystis*, *Pirocystis*, *Cryptocrinus*.

The apertures on the summit are as follows:—1. Central = Mouth; 2. Large lateral = Anus; 3. In the anal interradius between mouth and anus, sometimes close to the anus, sometimes even in the same genus (e.g. *Aristocystis*), further from it, = Genital aperture; in some cases this is contained in the anal aperture as in the recent starfish *Hymenaster* and *Pythonaster*; 4. A small opening by the side of the genital = Excretory aperture; this is seen in *Aristocystis*, and, as a "madreporic plate," in *Glyptosphæra*. In *Echinoencrinus* it is not so much in the anal interradius (C D) as in the next one (D E), and the single opening occupying this position in *Cystoblastus*, *Glyptocystis*, and other types, is probably of the same nature.

Geological Society of London.

I.—January 21, 1891.—A. Geikie, Esq., LL.D., F.R.S., President, in the Chair.—The following communications were read:—

1. "On the Age, Formation, and Successive Drift Stages of the Valley of the Darent; with Remarks on the Palæolithic Implements of the District, and on the Origin of the Chalk Escarpment." By Professor Joseph Prestwich, D.C.L., F.R.S., F.G.S., etc.

i. *General Character and Age of the Darent Valley.*—The river is formed by the union of two streams, the main one flowing east from near Limpsfield, the other west from near Ightham, parallel with the ranges of Lower Greensand and Chalk, and flows northward into the Thames. The first indent of the valley was subsequent to the deposition of the Lenham Sands, and indeed to the Red Clay with flints and the old implement-bearing drift with which this is associated; and the same remark applies to a system of smaller valleys starting near the crest of the escarpment and running into the Thames.

ii. *The Chalk Plateau Drifts and associated Flint Implements.*—Since the publication of the author's Ightham paper, Mr. Harrison and Mr. De B. Crawshay have found implements mostly of rude type (though a few are as well finished as those of Abbeville) in numerous localities on the plateau, where, owing to the gradients, the difference of level between plateau and valley-bottom is much greater than at Currie Farm. Evidence derived from the character and conditions of preservation of these implements is adduced in favour of their great antiquity.

iii. *The Initial Stages of the Darent Valley.*—The author has previously shown that in early Pliocene times a plain of marine denudation extended over the present Vale of Holmesdale, and that in pre-glacial times the plain was scored by streams flowing from the high central Wealden ranges. These streams centred in the

Darent, and the excavation of the present valley then commenced. There is a gap in the sequence between the pre-glacial drifts and the earliest post-glacial drifts of the valley, which is probably covered by the extreme glacial epoch. It was a time of erosion, rather than of deposition in this area. Of the earliest drift of the Darent valley, little has escaped later denudation. The bank of coarse gravel on the hill on the west side of the valley between Eynsford and Farningham, certain flint-drifts in the upper part of the valley, and a breccia of chalk-fragments on the hill west of Shoreham, may be referred to this period.

iv. *The High-Level or Limpsfield Gravel Stage.*—The gravel at Limpsfield occurs on the watershed between the Darent valley and the Oxsted stream, but the author agrees with Mr. Topley that the gravel belongs to the Darent system, and Westheath Hill may be part of the original ridge separating the two valleys. This gravel is post-glacial, and the denudation of the area had made considerable progress at the time of its formation, for the Chalk escarpment rises 200–300 feet, and the Lower Greensand 100–200 feet above the gravel-bed. The author traces outliers of this gravel down the valley at lower and lower points to the Thames valley at Dartford, and correlates it, not with the high plateau-gravel, but with the High-level gravel of the Thames valley, and shows that its composition indicates that it is derived from the denudation of the Chalk and Tertiary beds. Mr. A. M. Bell has discovered numerous implements in it, mostly of the smaller St. Acheul type, and the author hopes that they will soon be described by their discoverer. These implements agree in general type with the "Hill group" of the Shode valley, and not with the older group of the Chalk plateau, or those of the lower levels of the Thames and Medway.

v. *Contemporaneous Drift of the Cray Valley.*—Implements of this age have been found by Mr. Crawshay, and by Mr. P. Norman, near Green Street Green, in gravel which is more than 100 feet below the Red Clay of the plateau.

vi. *Brick-earths of the Darent Valley.*—These are traced along the upper course of the valley from near Limpsfield. They seem to show glacial influence, and Mr. Bell has discovered a few implements in them. The Limpsfield deposit is from 10 to 30 feet below the adjacent gravel. Brick-earth, possibly of somewhat later date, also occurs near Dartford.

vii. *Other Gravels of the Darent Valley*: *The Chevening and Dunton Green Drifts.*—The relations of the gravels grouped under this head are more uncertain than those of the Limpsfield stage. Various features in the gravels point to the temporary return of glacial conditions during the period of formation of these and the brick-earths; and these are described in detail.

viii. *The Low-level Valley-Gravels.*—The correlation of these is also uncertain. West of Dartford is a bed corresponding with that at Erith in which Mr. Spurrell found a palæolithic floor. It contains land- and freshwater-shells. The surface of the Chalk is here festooned under a covering of the fluviatile drift. The author attributes this festooning to the effects of cold.

ix. *The Rubble on the Sides and in the Bed of the Valley.*—The author describes this rubble, and rejects the view that it is rain-wash or due to subaerial action, and discusses the possibility of its having been produced by ice-action.

x. *Alluvium and Neolithic Implements.*—These occur chiefly between Shoreham and Riverhead.

xi. *On the Chalk Escarpment within the Darent District.*—The author, after discussing and dismissing the view that the escarpment was formed by marine denudation, criticizes the theory that it was due to ordinary subaerial denudation, and lays stress on the irregular distribution and diversity of the drift-beds in the Darent area; these do not possess the characters which we should expect if they were formed by the material left during the recession of the Chalk escarpment owing to subaerial action; and he believes that glacial agency was the great motor in developing the valleys and, as a consequence, the escarpment, and that the denudation was afterwards further carried on in the same lines by strong river-action and weathering, though supplemented at times by renewed ice-action. By such agencies, aided by the influence of rainfall and the issue of powerful springs, he considers that the escarpment was gradually pared back and brought into its present prominent relief.

2. "On *Agrosaurus Macgillivrayi* (Seeley), a Saurischian Reptile from the N.E. coast of Australia." By Professor H. G. Seeley, F.R.S., F.G.S.

The complete left tibia, a less perfect proximal end of the corresponding right tibia, a fragment regarded by the author as a fibula attached to matrix which contains two laterally compressed claw-phalanges, are preserved in the British Museum, and are labelled "Fly," 1844, J. Macgillivray, from the N.E. coast of Australia. These remains are described, and the distinctive characters which determine the fossil (the distal end of the tibia) noted. It shows an ordinal resemblance with *Pœkilopleuron* and *Cetiosaurus*, but with *Dimodosaurus* from the top of the Keuper it is so close that the two must be regarded as nearly allied. The fossil is regarded as generically distinct from all known types. The remains indicate an animal about the size of a sheep, and it is considered as not improbable that the creature belongs to the Lower Oolites or Trias.

3. "On *Saurodesmus Robertsoni*, a Crocodilian Reptile from the Rhætic of Linksfield, in Elgin." By Professor H. G. Seeley, F.R.S., F.G.S.

The bone described in this paper was found in a mass which has been interpreted as a large boulder of Rhætic beds in Boulder-clay. The specimen has already been noticed by Sir Richard Owen and R. Lydekker, Esq. The author maintains that the bone is a right humerus. He discusses its asserted Chelonian affinities, and concludes that it is not Chelonian but Crocodilian, but that, if grouped with the Crocodilia, it belongs to a suborder hitherto unknown, and defined by a combination of Crocodilian and Lacertilian characters which is not Saurischian.

II.—February 4, 1891.—A. Geikie, LL.D., F.R.S., President, in the Chair.—The following communications were read:—

1. "The Geology of Barbados and the West Indies.—Part I. The Coral Rocks." By A. J. Jukes-Browne, Esq., F.G.S., and Professor J. B. Harrison, M.A., F.G.S.

The authors first discuss the reef growing round Barbados and describe a submarine reef, the origin of which is considered; and it is pointed out that there is no sign of any subsidence having taken place, but every sign of very recent elevation. They then describe the raised reefs of the island, extending to a height of nearly 1100 feet above sea-level in a series of terraces. The thickness of the coral-rock in these is seldom above 200 feet, and the rock does not always consist of coral-debris. At the base of the reefs there is generally a certain thickness of detrital rock in which perfect reef-corals never occur.

The collections of fossils made by the authors have been examined by Messrs. E. A. Smith and J. W. Gregory. Of the Corals, five out of ten species identified still live in the Caribbean Sea, and one is closely allied to a known species, whilst the other four are only known from Prof. Duncan's descriptions of fossil Antiguan Corals. The authors are of opinion that the whole of the terraces of Barbados, the so-called "marl" of Antigua, and the fossiliferous rocks of Barbuda are of Pleistocene age.

They proceed to notice the formations in other West Indian islands which appear to be raised reefs comparable with those of Barbados, and show that these reefs occur through the whole length of the Antillean Chain, and indicate a recent elevation of at least 1300 feet, and in all probability of nearly 2000 feet. It appears improbable that each island was a region of separate uplift, and as a plateau of recent marine limestone also occurs in Yucatan, this carries the region of elevation into Central America, and it is reported that there are raised reefs in Colombia. The authors conclude that there has been contemporaneous elevation of the whole Andean Chain from Cape Horn to Tehuantepec and of the Antillean Chain from Cuba to Barbados. Before this there must have been free communication between the Atlantic and Pacific Oceans, which is confirmed by the large number of Pacific forms in the Caribbean Sea. Under such geographical conditions the great equatorial current would pass into the Pacific, and there would be no Gulf Stream in the North Atlantic.

2. "The Shap Granite, and the Associated Igneous and Metamorphic Rocks." By Alfred Harker, Esq., M.A., F.G.S., and J. E. Marr, Esq., M.A., Sec. G.S.

The authors describe the normal granite of the intrusion, and discuss the characters of certain variations from the usual type.

The dykes and sills of the neighbourhood are also considered; the similarity of some of these to certain inclusions in the granite is noticed; and reasons are given for supposing that many of the felsites and mica-traps of this region are connected with a magma which was intruded amongst the Lower Palæozoic rocks in pre-

Carboniferous times, and with which the Shap granite is itself connected.

The metamorphic effects of the granite upon the surrounding rocks are then described. A remarkable set of changes produced in a series of andesites and another of rhyolites, with their respective pyroclastic rocks, is considered in detail, and the results of the metamorphism of the Coniston Limestone series and the Coniston Flags and Grits are given and compared with those obtained by other workers in Norway, the Harz Mountains, and elsewhere.

CORRESPONDENCE.

MR. OLDHAM ON THE HIMALAYAS.

Sir,—It is needless to say how much it has pleased me that Mr. Oldham's knowledge of the structure of the Himalayas confirms in his opinion my theory, published in the "Physics of the Earth's Crust," concerning the formation of a mountain range, and of the effects of its subsequent denudation. I wish, however, to point out that the latter are in my work discussed on the hypothesis that the chief streams are formed, and deposit their sediment, on the less steep side of the range. I had rather the instance of the Andes in my mind as a typical range of mountains. With the Himalayas the case is different. The great rivers, Indus and Ganges, after collecting their burden of detritus during long courses between the parallel ridges, finally break through the steep face of the range, and form their deposits on that side. Hence arises the modification of my theory, which Mr. Oldham has found it necessary to make in applying it to the denudation of the Himalayas. O. Fisher.

Harlton, Cambridge, 5 *Feb.* 1891.

MR. MELLARD READE AND THE HERSCHEL-BABBAGE THEORY OF MOUNTAIN BUILDING.

Sir,—The theory of the formation of mountains set forth by me in "The Origin of Mountain Ranges" has been so frequently of late alluded to as a modification of the "Herschel-Babbage" theory, that I shall feel much obliged if one of those who think it so will kindly set forth what the "Herschel-Babbage" theory is. I fear that my friend Mr. O. Fisher is largely responsible for this description of my theory.[1] I have examined his references to the works of Herschel and Babbage, and must certainly repudiate the labelling as a misdescription. There is no analogy between Herschel's view of the elevation of mountains and mine, and indeed by a sort of dramatic justice I find that Mr. R. D. Oldham[2] commends Mr. Fisher's work as containing the "most recent and complete adaptation of this (the Herschel-Babbage) doctrine to the theory of mountain formation."

As a matter of fact, the only element in my theory taken from either of these distinguished men is the law discovered by them that the lines of equal internal temperature in the Earth's crust (isogeo-

[1] Physics of the Earth's Crust, second edition, p. 132.
[2] Geol. Mag. Feb. 1891, p. 73.

therms) must move upwards into new deposits as they are laid down. This is duly acknowledged in chap. vii. and credited to Babbage, who, I believe, has priority; but should the use of a natural law in building up a theory disentitle the theoriser to the full right of property in his own theory?

It is said, "What's in a name?" To which I answer, A great deal that is bad when it is vague and misleading and perpetuates errors and misconceptions.

T. Mellard Reade.

Park Corner, Blundellsands, *Feb. 9th*, 1891.

CRINOIDAL STEMS IN ORDOVICIAN OF SWEDEN.

Sir,—I am glad to have elicited from Dr. Holm such interesting information about the crinoid stems that he has found in the Leptænakalk of the Lissberg. But I am sorry that my remark has given rise, perhaps not unnaturally, to some misunderstanding. Dr. Holm in his original notice says two things:—First, that the rock is "chiefly composed of corals, cystids, and crinoid stems;" secondly, that he himself has found there "crinoid stems belonging to at least two species." Now I never doubted that so experienced a palæontologist as Dr. Holm had very good reasons for this latter statement; his letter shows how sufficient those reasons were. Nor did I "without having seen a single one of them," venture to assert that all the stem-fragments belonged to Cystidea. I was indeed well aware of the sessile nature of the majority of the Cystidea from this locality. But, remembering as I did how often stems undoubtedly cystidean had been referred to Crinoids, and knowing that not a single Crinoid had been recorded from the Ordovician of Sweden, though 23 species of Cystidea showed the possibility of their preservation, I merely wished, as indeed I still wish, to suggest that some of these ossicles might have pertained to the long and exceedingly crinoid-like stem of *Caryocrinus*. So inevitable did this seem that, though I did not so far forget either myself or Dr. Holm's very valuable works as to call him a mere collector, still I did express myself in a manner which now seems to me to need an apology, and this I trust, Sir, you will here permit me to offer.

F. A. Bather.

5 *Feb.* 1891.

MOTION OF LAND-ICE.

Sir,—As I have paid some attention to Glaciers,[1] I should like to make a few remarks on the paper by Mr. Goodchild on "The Motion of Land-ice" in the Geol. Mag. for January last, pp. 19–22.

1. The expansion and contraction of ice for changes of temperature below 0° C. and under a pressure of one atmosphere is but an example of the general law for solids, which has been recognized for many years in physical science; and the power of ice to resist tensile strain is (as Helmholtz has pointed out) so small as to furnish an explanation of the formation of crevasses, though these are not by any means always produced by contraction due to lowering of temperature. But this very property of ice shows that contraction

[1] Q.J.G.S. vol. xxxix. pp. 62–71, "On the Mechanics of Glaciers"; also 'Nature,' vol. xxvii. pp. 553, 554, "On Solar Radiation and Glacier-motion."

of the upper layers can neither help (*per se*) the downward flow when the temperature rises again, because the expansion being equal to the previous contraction (*cet. par.*), it must result merely in the closing-up of the shrinkage-cracks; nor can it tend to produce a curvature of the lower layers (after the fashion of the balance-wheel of a chronometer) as seems to be suggested later on in Mr. Goodchild's paper. In the former case water, produced by the melting either of the surface of the glacier or of the snow-mantle overlying it, during hours of sunshine, and flowing into the cracks, would certainly by its expansion in freezing do some work; but what becomes of its *latent heat?* The distribution of this in the neighbouring ice needs to be considered.

2. If by 'cold-waves' Mr. Goodchild means (as I take it) 'flows' of heat by conduction from the warmer interior to the surface whose temperature is below 0° C., it is a pity he did not speak of it as such. Cold, like darkness, is a negation; and we can only speak of a wave of either metaphorically.

3. We had no need to go back nearly half a century to Brunner's investigations to convince us that the 'sole' of a glacier moves down a slope; the observations and measurements by Tyndall, Helmholtz, Forbes, Agassiz, and others have made that pretty certain.

4. As to the "uphill movements" postulated by Mr. Goodchild and many writers who have preceded him, I have for a long time been very sceptical, as may be seen from my papers referred to above; and the researches of Penck[1] on the glaciation of the Northern Alps have converted that scepticism into positive disbelief, since all that I have read or heard alleged, as evidence of such movements, is more rationally explained by the *overflow* of the glaciers beyond their valley-sides during periods of maximum glaciation, and by the phenomena of stranded lateral moraines during the recession of a glacier, with which every Alpine observer is familiar (*e.g.* the Morteratsch).

5. The theory of "isogeotherms" continued through the lower parts of a glacier will not work, except for a hypothetical case where the adjacent rocks and the ice were all considerably below 0° C., because no heat at any higher temperature could be conducted through or into the ice, as seems to be imagined: it would become latent in the melting of the ice at the contact. This is probably the reason why previous writers have "overlooked" the fiction which Mr. Goodchild has now gravely put forward as a "fact."

6. Mr. Goodchild has overlooked three factors essential to the construction of any sound physical theory of glacier-motion; (i.) liquefaction under pressure and regelation; (ii.) the "greenhouse-principle," the application of which to glacier-motion was demonstrated by myself in the paper in *Nature* already referred to; (iii.) the latent heat of water, the 80 gramme-units of heat given up by every gramme of water at 0° C. in the act of solidifying under ordinary pressure.

A. Irving.

Wellington College, Berks, *Jan.* 8.

[1] See "Die Vergletscherung der Deutschen Alpen," reviewed in the Geol. Mag. Dec. II. Vol. X. p. 174, *et seq.*

ELEVATION AND SUBSIDENCE IN CENTRAL AMERICA.

SIR,—Allow me to point out that Mr. W. Upham's letter in the February Number of this MAGAZINE is not an answer to my article in that for December, 1890; because he completely ignores the point of my communication and re-asserts views which I did not question.

In his original article of November, 1890, Mr. Upham cited the Gulf of Mexico as having partaken in the high continental elevation and in the subsequent subsidence to an extent of 3000 feet. In December I quoted facts to prove that on the south side of the Gulf of Mexico there has been a recent upward movement of probably 2000 ft. Hence if the Mississippi subsidence was contemporaneous with the Cuban elevation, there must have been a differential movement of 5000 feet within a comparatively small area.

I do not say the difficulty is unsurmountable; the axis of the one oscillation may not have been located along the same parallel as the axis of the other oscillation, or if Mr. Upham likes he can postulate a great east and west fault through the Gulf of Mexico, with a downthrow on the north of about 5000 feet. The point, however, does require notice, and it is not noticed at all in the letter which purports to be a reply. I will therefore put the difficulty more fully. During Pliocene and Pleistocene time there was in North America a great elevation followed by a great subsidence; and in Central America a subsidence followed by great elevation. If these movements were correlative, should we not expect to find a zone where there was no movement at all? Would not the greatest vertical displacement be found in Canada or the Northern States, and the least in the Southern States, and would not the evidences of subsidence die away southward, and then be replaced by evidences of upheaval? Instead of this, we find the movements almost at a maximum in those parts of the two areas which are nearest to one another. Can Mr. Upham refer to any evidence about alteration of levels along the west coast of the Gulf of Mexico?

In a paper just read before the Geological Society, I have adduced evidence of the recent uprise of the Caribbean and Panamic region, and have advocated the view that the Gulf Stream passed into the Pacific while the Glacial Period prevailed in the North Atlantic. I am therefore strongly disposed to agree with the general views put forward by Mr. Upham as to the geographical conditions that prevailed during that period; but in generalizing about the movements which have affected such vast areas, we cannot be too careful about the accuracy of the data on which the inferences are based, and nothing is gained by ignoring difficulties.

It was because I thought that this difficulty might not have occurred to Mr. Upham that I put it before him; but I shall be very pleased to see it answered in a manner that will strengthen Mr. Upham's theory of correlative movements, and I hope Dr. Spencer, who wrote much more cautiously than Mr. Upham, may shortly have something to say about the date of the great depression.

TEIGNMOUTH, *February 7th.* A. J. JUKES-BROWNE.

OBITUARY.

GEORGE WAREING ORMEROD, M.A., F.G.S.

Among the losses recently sustained by geological science, we have to record that of Mr. G. W. Ormerod, who died at Teignmouth on January 6th, aged 82. He was a son of the late George Ormerod of Tyldersley House, Lancaster, and Sedbury Park, Gloucester, well known as the author of "The History of Cheshire." The Ormerods were a family which had been connected with Ormerod Hall, near Burnley, in Lancashire, since the time of Edward III.

G. W. Ormerod, after taking his degree at Oxford, practised for some years in the law at Manchester; he subsequently resided at Chagford on the borders of Dartmoor, and for the last twenty years at Teignmouth. To the country in which he resided he devoted most of his attention as a geologist. His papers included the following: an Outline of the principal Geological Features of the Salt-field of Cheshire and the adjoining districts; on the "Waterstone Beds" of the Keuper; on some Veins of Granite in the Carbonaceous Rocks on the North and East of Devon and East of Dartmoor; Geology of the upper part of the valley of the Teign; on the Structure of the Granite of Dartmoor; and papers on the New Red rocks of the neighbourhood of Teignmouth. To geologists he was perhaps best known as the compiler of the Classified Index to the Transactions, Proceedings, and Quarterly Journal of the Geological Society, of which the third supplement (up to 1889) was published last year. He was one of the original members of the Devonshire Association, and one of the founders of the Teign Naturalists' Field Club, of which for many years he was Secretary.

WILLIAM DAVIES, F.G.S.

We regret to record the death of Mr. William Davies, F.G.S., for forty-four years connected with the Geological Department of the British Museum. Mr. Davies was born at Holywell, Flintshire, in 1814, and entered the Museum on 19th Dec. 1843. He had already studied Botany, and had made a good *Hortus siccus* of British plants. Under Mr. Charles König, he devoted himself to Mineralogy, and soon became an excellent eye-mineralogist. He also worked at the fossil fishes in the Museum, many of which he afterwards described in this Magazine. He devoted many years of patient study to the fossil Vertebrates, but his knowledge was generously given to others as soon as solicited. With Sir Antonio Brady he formed a fine collection of the Mammalian-remains from the Thames-Valley Brick-earth, which he described and catalogued. The Geological Society of London, in 1873, awarded Mr. Davies the first Murchison Medal; and in 1877 elected him a Fellow of the Society, the Council presenting him with the Life Fellowship.

In 1875 Mr. Davies was made an Assistant, and in 1880 promoted to the First Class, in recognition of his valuable services. He took a very active part in the removal and re-arrangement of the Geological Collections at Cromwell Road, from 1880 to 1887, when he retired on a pension. He died on the 13th February last, warmly esteemed and deeply regretted by all who knew him.

A list of his papers will appear in next month's issue.—H. W.